THE ROTATION PERIOD OF THE SUN

AS DETERMINED FROM THE MOTIONS OF THE CALCIUM FLOCCULI

BY

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PUBLISHED BY
THE CARNEGIE INSTITUTION OF WASHINGTON
1908

CARNEGIE INSTITUTION OF WASHINGTON

PUBLICATION NO. 93

The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

THE ROTATION PERIOD OF THE SUN AS DETERMINED FROM THE MOTIONS OF THE CALCIUM FLOCCULI.

The rotation period of the Sun has been determined by three independent methods: (1) from measurements of the motions of the spots in longitude; (2) from measurements of the motions of the faculæ in longitude; and (3) from spectroscopic measurements of the motion in the line of sight of the approaching and receding limbs. The first series of monochromatic photographs of the Sun, made with the spectroheliograph of the Kenwood Observatory in the years 1892-94, has provided material for a new determination of the rotation period, based upon the motions in longitude of the calcium flocculi. Through a grant from the Carnegie Institution it became possible to undertake the measurement of these plates at the Yerkes Observatory. The results of this investigation are contained in the present paper.

THE KENWOOD SPECTROHELIOGRAPH.

The spectroheliograph employed in the present investigation is shown in plate 1, attached to the eye-end of the Kenwood refractor of 12 inches (30.5 cm.) aperture and 18 feet (5.49 m.) focal length. It consisted of a large grating spectroscope, with collimator and camera of 3.25 inches (8.4 cm.) aperture and 42.5 inches (108 cm.) focal length, inclined to each other at an angle of 25°. The collimator and camera objectives were corrected for the K line. A 4-inch (10 cm.) Rowland plane grating, having 14,438 lines to the inch (5,684 lines to the cm.), stood at the intersection of the collimator and camera axes. The spectroheliograph was provided with two movable slits, one at the focus of the collimator (in the focal plane for K light of the Kenwood refractor), the other in the focus of the camera lens. Both slits, which were 3.25 inches (8.4 cm.) in length, were adjustable in width by means of micrometer screws. They were attached to carriages mounted on steel balls, movable across the axes of the tubes, at right angles to the spectral lines. A photographic plate-holder was supported just beyond the camera slit and, after drawing the slide, the plate-holder could be pushed forward by means of a cam until the surface of the plate almost touched the jaws of the slit. A small 90° reflecting prism was attached to the slit carriage on the side toward the grating, and by a suitable combination of lenses a portion of the spectrum could be viewed without disturbing the plate-holder. This was not used in practice, the K line (in the fourth-order spectrum) being brought on to the slit by observing lines in the green of the overlapping third order with a low-power, positive eye-piece. The motive power was

supplied by a specially designed clepsydra, mounted within the braced frame of the spectroscope. It consisted of a brass cylinder of 3 inches (7.6 cm.) bore and 6 inches (15.2 cm.) stroke, supplied with a three-way valve, permitting the liquid to flow in at one end of the cylinder and out at the other. The piston had a cup-shaped leather packing, and the phosphor-bronze piston-rod passed through a stuffing-box in the upper head. At the end of the rod a system of bell-crank levers was attached, which conveyed the motion to the slit at the focus of the camera objective. An extension of the piston-rod passed through a guide in the upper frame of the spectroscope, and connected with the first slit by another lever system. It will be seen that when the piston was set in motion, the two slits would move simultaneously, and in opposite directions, the first slit across the solar image, the camera slit, containing the K line, across the photographic plate. Water pressure was supplied to the clepsydra from a tank, in which the pressure was kept constant by means of an automatic pump. In winter, alcohol or glycerin was mixed with the water to prevent freezing.[1]

This spectroheliograph, though it gave satisfactory photographs of the prominences and flocculi, had one important disadvantage: the distortion of the image resulting from the motion of the slits.

In the equation for the plane reflection grating

$$\lambda = \frac{d}{n} (\sin \theta \pm \sin \omega)$$

$\theta =$ angle of diffraction,
$\omega =$ angle of incidence,
$\lambda =$ wave-length of line observed,
$n =$ order of spectrum employed,
$d =$ distance between adjacent lines of grating.

Then

$$\sin \theta = \frac{n\lambda}{d} \pm F \sin \omega$$

Differentiating, we have

$$d\theta = \frac{\cos \omega \, d\omega}{\cos \theta} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$\frac{n\lambda}{d}$ being a constant for a given line.[2]

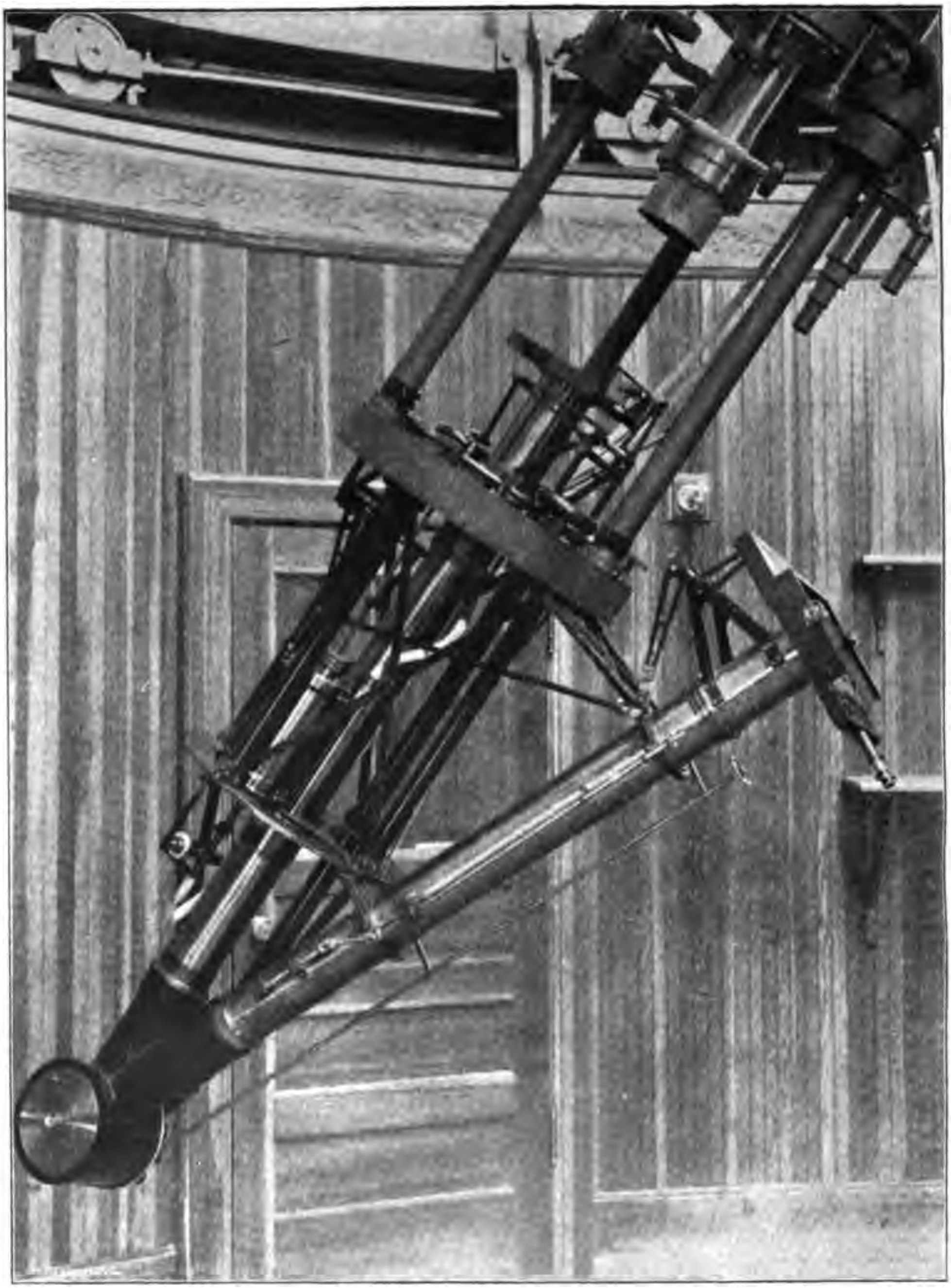
In the case of the Kenwood Observatory spectroheliograph, when used in photographing an image of the Sun 51 mm. in diameter, we have

θ (maximum) $= 14° \, 36'$ $\qquad$ θ (minimum) $= 13° \, 42'$
ω (maximum) $= 40° \, 54'$ $\qquad$ ω (minimum) $= 38° \, 42'$

$$d\omega = 51 \text{ mm.}$$

[1] For a more complete description of this spectroheliograph, in its original form, see *Astronomy and Astro-Physics*, May, 1892, p. 407.
[2] See Young, *Amer. Jour. Sci.*, November, 1880.

PLATE 1.



THE SPECTROHELIOGRAPH OF THE KENWOOD ASTROPHYSICAL OBSERVATORY, CHICAGO.

Substituting in (1), we find $d\theta = 39.8$ mm. That is, the diameter of the photographed solar image which is parallel to the length of the spectrum will be reduced by the distortion from 51 mm. to 39.8 mm. The diameter parallel to the lines of the spectrum will of course remain undistorted. This result, however, is only approximate, as the distortion for equal values of $d\omega$ increases from one side of the image to the other. Thus if we make $d\omega = 1$ mm., and calculate the values of $d\theta$ for one side, the center and the other side of the solar image, we obtain the respective values

$d\theta = 0.78$ mm. (for maximum value of θ)
$d\theta = 0.79$ mm. (for mean value of θ)
$d\theta = 0.80$ mm. (for minimum value of θ)

In measuring photographs distorted in this way the necessary correction for a point at a given distance from the Sun's limb might be taken from a table, readily constructed for a given position of the Sun's image with respect to the axis of the collimator. To define this position, means were provided for making the solar image concentric with the axis of the collimator. Care was always taken to orient the image so that the distorted axis should be parallel to the solar equator in the photograph. For this purpose the whole instrument could be rotated about the axis of the collimator, the direction of the slit being read off on a position circle. The parallel lines on the photograph (due to dust on the slit, which can not be altogether avoided in any form of spectroheliograph when the slit is narrow) were made to serve a useful purpose in the orientation of the image.

After a considerable number of distorted photographs had been taken with the instrument, a simple device was attached for the purpose of making the images practically circular in form. This consisted of a lever arm which moved the photographic plate, during the exposure, in a direction opposite to that of the motion of the second slit, and through a distance equal to the difference between the major and minor axes of the distorted image. It will be observed that this correction, though not perfect, is very nearly so. The modified instrument yielded photographs which were very nearly circular in form.[a]

The Kenwood spectroheliograph and all the optical parts of the Kenwood refractor were constructed by Brashear, whose valuable services and cordial cooperation greatly facilitated the investigations of the Observatory. Warner & Swasey also gave much useful assistance, in addition to their work of constructing the telescope mounting and dome.

During the years 1892-94 there were obtained with the Kenwood spectroheliograph 2,295 photographs of the Sun showing the calcium flocculi. In 1,408 of these photographs the image was elliptical (or approximately so)

[a] A mechanical device for copying distorted photographs, in such a way as to obtain a circular image, was also constructed at the Kenwood Observatory.

in form. These were obtained before the device for correcting the distortion of the image had been applied to the spectroheliograph. By means of the apparatus devised for the purpose, these negatives might have been copied in such a way as to give circular images, in which case they would have been available for the present investigation. But in view of the much greater excellence of the photographs which were being obtained with the 40-inch Yerkes Observatory telescope, when the present reduction of the Kenwood plates was undertaken, it was decided to confine the work to the measurement of the circular images, 887 of which were available. Mention has not yet been made of the slight distortion of the Sun's image, caused by the curvature of the spectrum lines in the Kenwood spectroheliograph.[4] Since the motion of the photographic plate, which served to transform the elliptical image into a nearly circular one, did not also furnish the means of correcting for the curvature of the slit, precautions had to be taken, while making the photographs, to eliminate the effect of this curvature. For this reason, the plates were made in two series, in one of which the slits were made parallel to the Sun's axis, while in the other they were placed in a position angle 90° from this. For the present investigation the plates of the first series were employed, since the displacement (due to curvature) of the flocculi in longitude would be, in this case, only a second-order effect, too small to be appreciable in photographs no sharper than those available. In order to avoid errors in the identification of the flocculi measured, no attempt was made to employ plates separated by two or more cloudy days. The best plate, corresponding to each day in a series of two or more clear days, was selected for measurement. In this way the number of plates to be measured was reduced to 138, covering the period 1893 July 31 to 1894 September 29.

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[4] Radius of curvature = about 1 m.

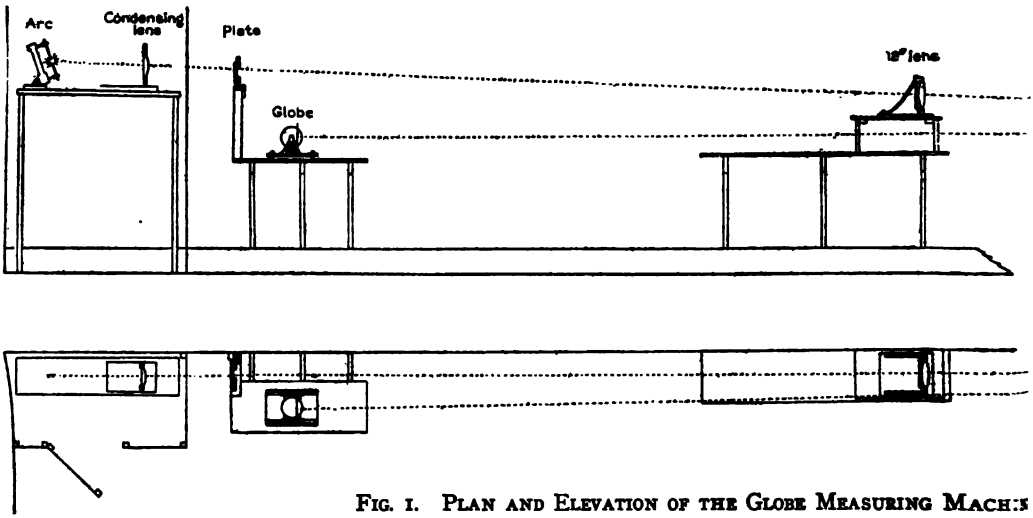


FIG. 1. PLAN AND ELEVATION OF THE GLOBE MEASURING MACH:S

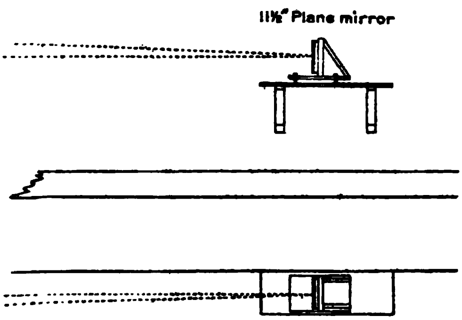
METHOD OF MEASUREMENT.

Two causes made it undesirable to adopt the ordinary method of measurement in the reduction of these photographs. In the first place, the high degree of precision attainable in measuring very sharp direct photographs of the Sun, such as those comprised in the Greenwich series, is out of reach in the case of photographs taken with such an instrument as the Kenwood spectroheliograph. In the second place, the measurement and reduction by the ordinary process of the numerous positions required would have been a larger task than could be undertaken in the intervals of work with the Rumford spectroheliograph. Accordingly a new method of measurement was devised by Mr. Hale, which is at once exceedingly rapid in execution and, at the same time, sufficiently precise for the immediate object in view.[1]

The photographs are projected by means of the light of an electric arc lamp upon a globe accurately ruled with a series of meridians and parallels. The details of the arrangement are described below. The greater part of the apparatus was constructed in the instrument shop of the Yerkes Observatory (see fig. 1). References to this apparatus will be used as follows:

$A =$ Arc lamp, fed by clock-work so as to keep the arc at a fixed point.
$C =$ Condensing lens, 10 inches (25.4 cm.) in diameter.
$P =$ Plate-holder, which carries the solar negative.
$L =$ 12-inch (30.5 cm.) objective of 18 feet (5.49 m.) focal length, which forms an image of the photograph upon the globe, G.
$M =$ Plane mirror inserted in the path of the rays, to secure the necessary distance of the globe from the lens, in the limited space available. The globe must subtend an angle of 32′ as seen from the lens.

THE GLOBE.



The globe is of cast-iron, accurately turned to form a sphere 9.53 inches (24.21 cm.) in diameter. It was enameled white to receive the ruling, and afterwards reworked to a spherical form. In order to rule the parallels of latitude, centers were drilled at points corresponding to the north and south poles, and the globe was mounted in a Brown & Sharpe milling machine, between the spindle and the overhanging arm. A support for a ruling-pen was clamped to the spiral head, the pen resting on the globe. The position of the equator was determined by

[1] For an improved form of globe-measuring machine (the Heliomicrometer), capable of giving results of the highest precision, see *Contributions from the Solar Observatory*, No. 16; *Astrophysical Journal*, June, 1907.

careful measurement and ruled by rotating the globe. The support carrying the pen was then moved through 1° by means of the index plate, and the parallel was drawn by again rotating the globe. After the parallels to 60° north and south had been ruled in this way, those at 5°, 10°, 15°, etc., were slightly strengthened; the parallels marking the 10° zones, viz.: 10°, 20°, 30°, etc., were still further strengthened to facilitate the readings.

To rule the meridians, the globe was mounted on the cross-table of the milling machine, with the centers again at the poles, and was clamped to the spiral head, so that it might be rotated through any desired angle by means of the index plate. The pen was mounted on an arm, permitting it to be moved in a great circle from pole to pole. The first line ruled, which we shall subsequently call the central meridian, was carefully located midway between the centers on which the globe was ultimately to rest. These had been drilled at points on the globe exactly 90° from the poles. Hence, this axis passes through the globe as a diameter in the equatorial plane. After the principal meridian had been ruled, by moving the pen from pole to pole, the other meridians were successively ruled at 1° intervals, accurately determined by means of the index plate. As in the case of the parallels of latitude, the meridians marking the multiples of 5° in longitude were strengthened, and those at 10°, 20°, 30°, etc., were made still heavier.

The ruled globe was mounted as shown in plate 2. When supported in this way, any motion of rotation, producing a change in the inclination of the globe's axis, corresponds to a change in the inclination of the Sun's axis with reference to the ecliptic. With the aid of an index moving over a divided arc, the globe may be set so that the heliographic latitude of the center of the globe corresponds to that of the Sun's center on the day when the photograph to be measured was taken.

The globe and support can be moved on rails toward or from the projecting lens, so that the varying diameter of the solar image, at different seasons, can be made to correspond with the diameter of the globe. The entire apparatus rests on a strong shelf, supported on brackets from a brick wall in the basement of the Yerkes Observatory.

PLATE-HOLDER.

The plate-holder, fig. 2, is provided with spring clips for holding the plate firmly in position. The disk which carries the plate may be rotated in a plane perpendicular to the beam of light, the orientation of the plate being read on a divided arc. The Kenwood spectroheliograph could be rotated so that the motion of the slits in the instrument was parallel to the Sun's axis for the date on which the photograph was made. With this adjustment of the instrument, which was always made for plates of the first series, a line drawn upon the plate by a needle crossing the first slit may always be taken to correspond with the direction of the Sun's axis. By clamping the plate in

the holder, so that the line corresponds with the zero of the scale, the position-angle of the Sun's axis is accounted for.* The plate-holder is mounted in a fixed position on a shelf just behind and above the globe, and has no motion in the direction of the beam. Two motions are provided for centering the image on the globe. The east and west setting is accomplished by moving the plate-holder toward or away from the wall, while the north and south motion is produced by raising or lowering the plate-holder in its supporting frame by means of a double wedge. The centering of the image is done on a fixed screen, mounted in front of the globe, as shown in plate 2. The

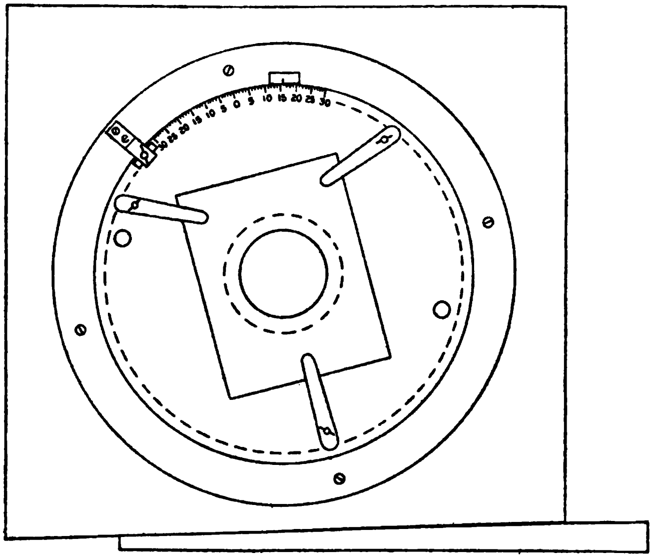


FIG. 2. THE PLATE-HOLDER.

position of the plate-holder is such that it may be adjusted by the operator while he is observing the globe, thus rendering the centering a simple matter. The operation of mounting the plate in the plate-holder, the setting of the globe and the orientation of the image, occupies from 5 to 10 minutes.

PROJECTING LENS.

The lens L, which is used to form an image of the plate on the globe, is a 12-inch (30.5 cm.) photographic objective, of 18 feet (5.49 m.) focal length, which was formerly used with the Kenwood telescope. The position of the

* The Rumford spectroheliograph can not be rotated; but the dust-lines show the direction of the plate's motion (north and south). In measuring photographs made with this instrument, the plates are clamped with the dust-lines parallel to the zero line on the disk, after which the disk is rotated through an angle equal to the position-angle of the Sun's axis, for the day on which the plate was taken.

lens, between the plate-holder and the globe, is necessarily dependent upon the position of the globe itself. Since the globe must be moved to correspond with the change in diameter of the solar image, the lens is correspondingly moved by an amount such as to retain the plate and globe in the conjugate foci of the lens.

Theoretically, the angular diameter of the globe, as seen from the lens, should be the same as the angular diameter of the Sun as seen from the Earth.[1] This would place the globe at a distance of about 84.26 feet (25.68 m.) from the projecting lens. Since the diameter of the image on the Kenwood plates is 2 inches (50.8 mm.), when the angular diameter of the Sun is 32′, the lens should have a focal length of about 14.84 feet (4.51 m.), in order that the projected image may correspond in diameter with the globe. No lens of this focal length, and of sufficiently large aperture, was available, and accordingly the 12-inch objective was employed. As the distance of the globe from this lens was 103.8 feet (31.64 m.), a small error enters into the measurements. In the triangle, Sun's center, flocculus, Earth, we have introduced an error in the angle at the Earth usually designated s' or ρ'.

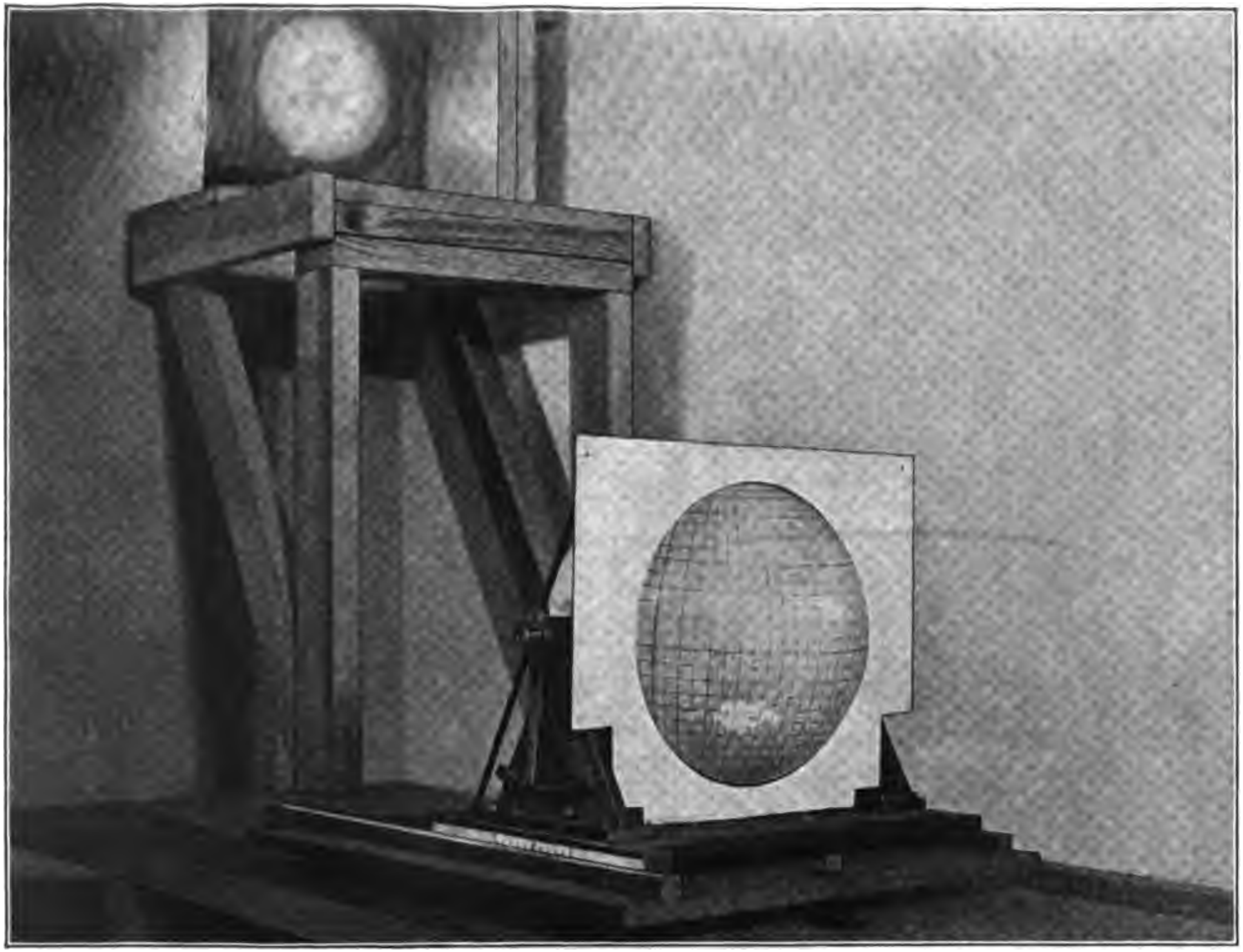
This angle s' enters into the solution of the solar triangle, pole, flocculus, center of the disk, as a correction in the arc, flocculus, center of the disk, usually called s or ρ, and at the limb, has its maximum value of 16′. In our case s_1' is smaller, having a maximum value of 13.1′. That is, every point would appear to be slightly shifted toward the center of the globe. Even in the case of the maximum difference the error is inappreciable. In order to avoid the errors always incident to measures of objects lying near the limb in solar photographs, the measures of the present series of plates have been confined to regions lying within 45° of the central meridian. On account of the rarity of occurrence of large flocculi in high heliographic latitudes, it was unnecessary to set a limit in the direction north and south. In the extreme cases, where the measured position is 45° east or west of the central meridian, and 45° north or south, the difference between the true s' and our erroneous value is $s' - s_1' = 2.4'$. Had this difference been appreciable, it might have been eliminated for the region in which the measures are confined by slightly enlarging the circle on the screen in front of the globe, with which the image is always made to coincide.

ARC AND CONDENSING LENS.

The arc and condensing lens are inclosed in a small room, in order that the general illumination on the globe may be minimized. As already remarked, the arc is of the focusing type, with inclined carbons. The condenser is a plano-convex lens, 10 inches in diameter.

[1] The theory of the globe-measuring machine will be published in a subsequent paper.

PLATE 2.



THE RULED GLOBE WITH PHOTOGRAPH OF FLOCCULI PROJECTED UPON IT.

(The Photograph Shows the Large Flocculus Surrounding the Great Sun-spot of October, 1903.)

ADJUSTMENTS.

The principal adjustments are as follows:

(1) The plate should be normal to the line joining center of globe and center of plate.

(2) The 12-inch projecting lens should be collimated in this line.

(3) The rails on which the globe slides should be parallel to this line.

(4) The axis of the globe must be adjusted in azimuth (perpendicular to the line of collimation) and leveled so that a straight perpendicular line on the plate can, in projection, be made to coincide with the central meridian.

(5) When the globe is so adjusted, through rotation on its axis, that a horizontal line on the plate, in projection on the globe, coincides with the equator, the index which gives the inclination of the Sun's axis must read zero.

PROCESS OF MEASUREMENT.

The operations to be carried out in measuring a plate are as follows: The plate is mounted in the plate-holder, so that the line parallel to the solar axis corresponds approximately with the zero of the scale. The arc is started, and the accurate adjustment for position-angle is made by rotating the plate until the projected line coincides with the central meridian of the globe. The axis of the globe is then inclined so as to make the heliographic latitude of the center of the disk correspond with that of the center of the Sun's disk on the day in question. The image is then centered in the circle on the screen, the globe is moved until the image falls exactly within the circle, and the projecting lens is moved, if necessary, to preserve the focus. In measuring the flocculi the image is received upon a small white card, from which it is dropped upon the globe by rapidly moving the card aside. As the card is free from the lines ruled on the globe, the image can be seen upon it to better advantage. The positions of the points in heliographic latitude and longitude from the central meridian are read off directly, by estimation, to the nearest tenth of a degree.

The identification of points to be measured requires much care, in view of the complexity of the changes of form of the flocculi. Prints from the original negatives were made on "Velox" paper, and all measured points were carefully marked. By comparison of the prints, the points can be followed from day to day, thus assuring certain identification. The flocculi change in form rather rapidly, but a number of points were followed for four, five, and six days. Of the 1,213 points measured, 647 correspond to intervals of one day; 331, to two days; 137, to three days; 65, to four days; 26, to five days; and 7, to six days. The positions of all points were estimated to a tenth of a degree.

SOURCES OF ERROR.

In considering the many sources of error that may affect our results, the character of the photographs must always be borne in mind. The small size of the solar image; the lack of sharpness of the flocculi; and their rapid changes of form, making identification of points for measurement very difficult, all tend to reduce the accuracy of the results. As compared with such investigations as those of Stratonoff on the motion of the faculæ, however, we have two important advantages which reduce, if they do not completely offset, the disadvantages arising from the above causes. These include:

(1) The possibility of making all measures near the center of the disk, instead of near the limb.

(2) The greater number of objects available for measurement, and the consequent better distribution of the points in latitude.[a]

The following sources of error must be considered:

(1) Distortion of the solar image, arising from—

(a) The different rates of motion of the first and second slits (p. 3). This is corrected, with sufficient exactness for the present work, by the motion of the photographic plate during the exposure.

(b) Errors in centering the solar image on the first slit. It is evident from the equation of the grating that the degree of the distortion of the image depends on its position with respect to the axis of the collimator. For any slight deviations of the solar image from the central position, however, the effect is small, and much less than that due to (*a*).

(c) Curvature of the second slit. When taking the photographs, the effect of curvature was reduced to an inappreciable quantity of the second order by setting the slit in all cases parallel to the solar equator. The latitudes are thus mainly (though but slightly) affected, while the longitudes suffer only in the second order.

(2) Errors of globe divisions. These were found on examination to be so small that they could safely be neglected.

(3) Care was always taken in the orientation of the image and in centering it on the globe. The accidental errors arising from these sources were undoubtedly small.

(4) The focal length of the only lens of sufficient aperture available for the projection of the solar photograph on the globe was 18 feet (5.49 m.) instead of 14.8 feet (4.51 m.), required by theory. The errors due to this cause have been shown to be inappreciable.

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[a] This applies particularly to well-defined images, in which the minute flocculi are shown.

ROTATION PERIODS DERIVED FROM THE MEASURES.

About 3,000 measures were obtained, of 1,213 points in the flocculi. The actual heliographic longitudes of the flocculi were not measured, but only their differences in longitude east or west of the central meridian. The latitudes of all the points were measured; but they are, of course, affected by the slight error due to curvature of the second slit. This does not exceed 0.6° in the extreme case and affects only the grouping of the different flocculi into zones in taking the mean value for each zone. As the spectroheliograph was sometimes oriented with the convex side of the curved second slit north and sometimes with the convex side south the error of grouping will be practically self-compensating.

In gathering together the different measures of the same point, to determine the rotation period, the first reading was taken as zero degrees, and the others reduced accordingly. The readings thus assembled are given in table 1. It has not seemed necessary to publish all the measures from the original note-book. The plate number and date are given in the first column. The second column contains the flocculus number, as marked on the enlarged prints for the purpose of identification. The third column gives the zone in which the flocculus was found: $a = 0°$ to $5°$; $b = 0°$ to $-5°$; $c = 5°$ to $10°$; $d = -5°$ to $-10°$; $e = 10°$ to $15°$; $f = -10°$ to $-15°$; $g = 15°$ to $20°$; $h = -15°$ to $-20°$, etc.

The sixth, seventh, eighth, ninth, tenth, and eleventh columns show the movement in longitude during the days, or portions of days, intervening between the first and second plates, first and third, first and fourth, etc., of the flocculus in question. The fourth column gives the angular movement per day, as derived graphically from the readings, by platting the times as abscissæ, and the difference in longitude as ordinates. The rise of the line which best represents the observations, during an interval of 24 hours, is the desired angular movement.

The cross-section paper employed, for which we are indebted to Mr. Abbot, was specially ruled with great accuracy for the Smithsonian Astrophysical Observatory. The paper is ruled in millimeters, and the scale of platting is such that 5 mm. correspond to 1 hour in the abscissæ, and single millimeters to 0.1° in the ordinates. Heavy lines were ruled to correspond with the even 24 hours, and these were taken to represent the noon hour. The times of the plates were laid off, so many hours and minutes, right or left from this line, depending upon whether the plate was taken in the afternoon or forenoon. The first ordinate was 0, the second approximately 13°, etc., as given in columns 6, 7, 8, 9, 10, and 11.*

Let γ_1, γ_2, γ_3, ... represent the observed motions in longitude, corresponding to the times t_1, t_2, t_3, ... In general t_1, t_2, t_3, ... are not

* The graphical method described below is due to Dr. Frank Schlesinger.

exact multiples of 24 hours. In the case where we have three observations connect γ_1 and γ_3, and let λ_1 and λ_3 represent the values of the longitude corresponding to the intersections of this line with the noon lines of the first and third days. Similarly λ_2 is given by the intersection of the line joining γ_1 and γ_2 with the noon line of the second day. In the case of four observations, the values of λ_1, λ_2, λ_3, λ_4 are given by the intersections with the corresponding noon hours of the lines joining γ_1 and γ_4, and γ_2 and γ_3. Treat λ_1, λ_2, λ_3, ... as observed quantities, and call λ_0 the value of the longitude corresponding to zero time. By the method of least squares, the equations

$$\lambda_0 - \lambda_1 = 0 \qquad \lambda_0 + x - \lambda_2 = 0 \qquad \lambda_0 + 2x - \lambda_3 = 0$$

give at once

$$3\lambda_0 + 3x - (\lambda_1 + \lambda_2 + \lambda_3) = 0 \qquad 3\lambda_0 + 5x - (\lambda_2 + 2\lambda_3) = 0$$

whence

$$x = \frac{1}{2}(\lambda_3 - \lambda_1)$$

Thus, in the case of observations made on three successive days, the position of the middle point does not affect the result; for in approaching the thread (which was used in place of drawing lines) to the middle observation, the inclination is not changed. This is, of course, absolutely true only when the intervals are accurately equal to 24 hours, but it is a sufficiently close approximation in our observations. The error does not exceed 0.05° under ordinary conditions and 0.1° in a few extreme cases.

For four consecutive days we obtain

$$x = \frac{3}{10}(\lambda_4 - \lambda_1) + \frac{1}{10}(\lambda_3 - \lambda_2) = \frac{1}{10}\left\{9\left(\frac{\lambda_4 - \lambda_1}{3}\right) + (\lambda_3 - \lambda_2)\right\}$$

The second form here, as in the following cases, gives the weight assigned to the line through the extreme observations and to that through the intermediate ones.

In case the second day's observation is lacking

$$x = \frac{2}{7}(\lambda_4 - \lambda_1) + \frac{1}{14}(\lambda_3 - \lambda_1) = \frac{1}{7}\left\{6\left(\frac{\lambda_4 - \lambda_1}{3}\right) + \frac{\lambda_3 - \lambda_1}{2}\right\}$$

If the third day's observation is lacking

$$x = \frac{2}{7}(\lambda_4 - \lambda_1) + \frac{1}{14}(\lambda_4 - \lambda_2) = \frac{1}{7}\left\{6\left(\frac{\lambda_4 - \lambda_1}{3}\right) + \frac{\lambda_4 - \lambda_2}{2}\right\}$$

For five consecutive observations the middle one disappears, as in the case of three, and we find

$$x = \frac{1}{5}(\lambda_5 - \lambda_1) + \frac{1}{10}(\lambda_4 - \lambda_2) = \frac{1}{5}\left\{4\left(\frac{\lambda_5 - \lambda_1}{4}\right) + \frac{\lambda_4 - \lambda_2}{2}\right\}$$

With λ_2 or λ_4 missing, the solutions are similar, but too complex to be of value in platting.

If λ_2 and λ_3 are lacking, we find

$$x=\frac{5}{26}(\lambda_5-\lambda_1)+\frac{1}{13}(\lambda_4-\lambda_1)=\frac{1}{13}\left\{10\left(\frac{\lambda_5-\lambda_1}{4}\right)+3\left(\frac{\lambda_4-\lambda_1}{3}\right)\right\}$$

If λ_3 and λ_4 are lacking

$$x=\frac{5}{26}(\lambda_5-\lambda_1)+\frac{1}{13}(\lambda_5-\lambda_2)=\frac{1}{13}\left\{10\left(\frac{\lambda_5-\lambda_1}{4}\right)+3\left(\frac{\lambda_5-\lambda_2}{3}\right)\right\}$$

Fig. 3 illustrates the graphical solution of the observations of Flocculus No. 737. The observations were made on plates No. 3106, 1894, Mar. 14, $1^h 59^m$; No. 3112, 1894, Mar. 15, $1^h 12^m$; No. 3117, 1894, Mar. 16, $2^h 44^m$; and No. 3121, 1894, Mar. 17, $12^h 04^m$.

$$\gamma_1=0 \qquad \gamma_2=12.7 \qquad \gamma_3=26.2 \qquad \gamma_4=38.7$$

$$\lambda_1=-1.10^\circ \qquad \lambda_2=12.07^\circ \qquad \lambda_3=24.76^\circ \qquad \lambda_4=38.68^\circ$$

$$x=\frac{3}{10}(\lambda_4-\lambda_1)+\frac{1}{10}(\lambda_3-\lambda_2)=13.203$$

Or, extending the line $\lambda_2\lambda_3$ for the three days, it intersects the noon lines on the first and fourth days at α and β. Now, knowing that the line $\lambda_1\lambda_4$ has nine times the weight of $\lambda_2\lambda_3$, we may make a reading on $\lambda_1\alpha$ one-tenth the distance from λ_1 toward $\alpha=-1.05^\circ$ and on $\lambda_4\beta$ one-tenth the distance from λ_4 toward $\beta=38.56$

$$x=\frac{38.56+1.05}{3}=13.203$$

Or, as is most frequently done in practice, we may draw a third line $\lambda_1\delta$ parallel to $\lambda_2\lambda_3$ passing through λ_1.

Again read on $\lambda_4\delta$ one-tenth the distance from λ_4 toward $\delta=38.50$

$$x=\frac{38.50+1.10}{3}=13.200$$

In case we use the general formula and express t_1, t_2, t_3, t_4, in minutes,

$$x=1440\,\frac{k\,\Sigma\,(t\gamma)-\Sigma\,(t)\,\Sigma\,(\gamma)}{k\,\Sigma\,t^2-(\Sigma\,t)^2}$$

$$t_1=0 \qquad t_2=1393 \qquad t_3=2925 \qquad t_4=4205$$

$k=$ the number of observations, in this case 4,

we find

$$x=13.183$$

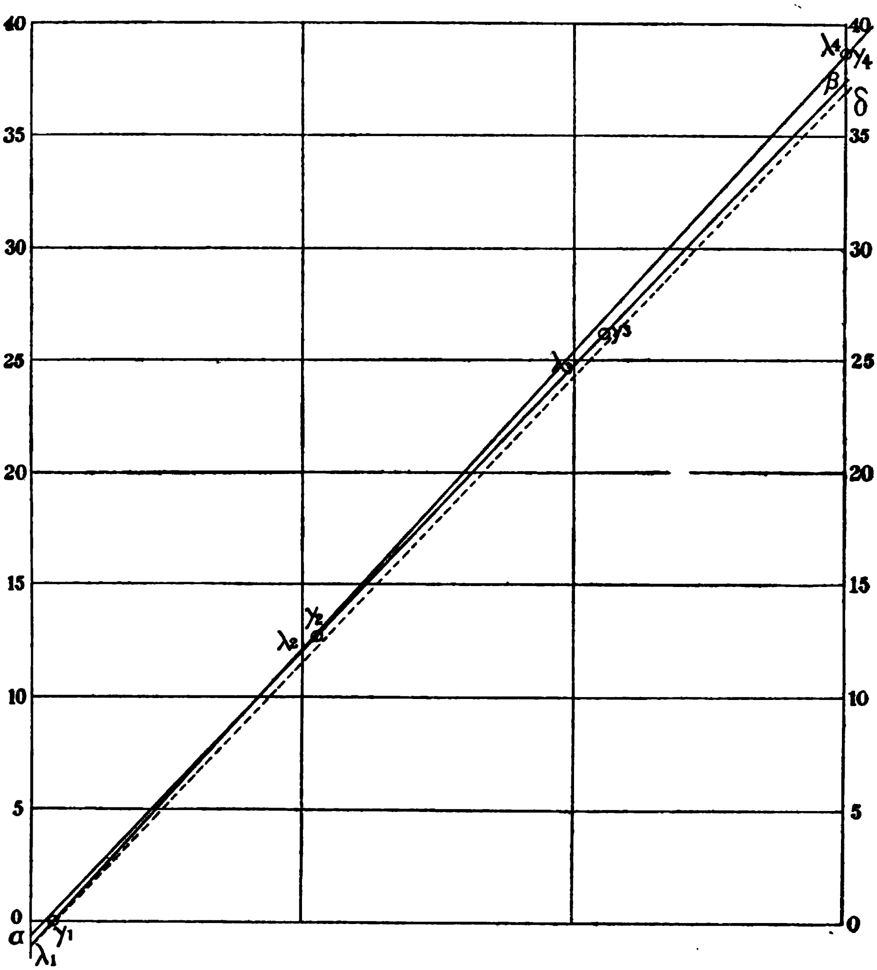

FIG. 3. GRAPHICAL INTERPOLATION METHOD.

TABLE I. *Diurnal Motions of the Flocculi.*

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 2401	1	*c*	14.74°	13.78°	12.6	26.6	39.9			
1893, July 31	19	*c*	14.84	13.88	11.7	25.9	39.7			
2^h27^m	5	*e*	14.03	13.07	10.6	24.6				
	5′	*e*	14.42	13.47	10.8	25.0	38.5			
	4′	*e*	14.38	13.42	10.8					
	18	*f*	14.26	13.31	10.1	25.1				
	23	*g*	14.06	13.10	10.7	24.3	37.4	51.0		
	2′	*e*	14.42	13.47	10.9	24.5	38.2	52.5		
	14	*h*	13.78	12.82	10.3					
	15	*h*	13.89	12.93	10.1	24.3				
	11	*j*	12.67	11.72	9.4					
	3′	*k*	13.64	12.68	......	23.3	36.1			
	8	*l*	12.61	11.65	9.9	21.6				
	8′	*l*	12.61	11.66	9.3					
	16	*l*	13.54	12.58	9.9	23.7				
	16′	*l*	13.19	12.23	9.8	23.1				
No. 2407	1′	*c*	14.62	13.67	13.6	27.0	41.8			
1893, Aug. 1	27	*d*	14.42	13.47	14.0	27.2	41.0			
9^h34^m	26′	*f*	14.41	13.45	14.5					
	26	*h*	12.54	11.58	12.1					
	3	*i*	14.59	13.64	14.2	27.3	42.0			
	6	*i*	14.29	13.33	14.1	27.3				
	22	*j*	12.07	11.11	13.8	26.7	40.3			
	6′	*k*	14.07	13.12	13.7	26.0				
No. 2421	32	*b*	13.99	13.04	12.6					
1893, Aug. 2	34′	*b*	14.72	13.76	13.6	27.3				
11^h30^m	38	*b*	15.24	14.29	13.8					
	36′	*b*	13.81	12.85	12.5	25.5				
	36″	*b*	14.26	13.30	13.7	26.4				
	37′	*c*	14.37	13.41	13.3	26.6	39.7			
	36	*d*	14.62	13.66	13.6	27.1				
	33	*e*	14.78	13.82	12.8	27.4				
	4	*i*	14.71	13.75	13.2	27.3				
	29	*i*	14.49	13.54	12.9	26.9				
	30	*i*	14.06	13.10	12.7	26.0				
No. 2429	35	*d*	15.87	14.92	15.4	30.1	48.7			
1893, Aug. 3	47′	*h*	14.22	13.26	13.3	26.7	43.4	51.9		
10^h42^m	30′	*i*	14.66	13.70	13.9					
	29′	*i*	14.66	13.70	13.9					
	47	*j*	13.71	12.75	13.1	25.8	43.9			
	38′	*l*	13.09	12.13	12.3					
	38″	*l*	14.35	13.39	13.6	......	44.4	53.4	66.7	
No. 2442	38‴	*b*	14.57	13.62	13.3					
1893, Aug. 4	52	*b*	14.75	13.79	13.9	31.7	40.9	54.5	69.2	
11^h7^m	53′	*b*	14.73	13.77	13.5					
	55	*b*	14.68	13.72	13.8	31.5	40.7	54.1	69.0	
	51	*d*	14.69	13.73	14.2	31.2	40.8	54.2	69.4	
	51′	*d*	14.93	13.97	13.3	31.7	40.8			
	23′	*e*	14.15	13.19	12.9					
	42	*e*	14.73	13.77	13.5					
	42′	*e*	14.19	13.24	12.6	29.8				
	44	*e*	13.69	12.73	13.0	28.8	38.2			

Table I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 2442—*Cont'd.*	44'	*e*	14.41°	13.45°	13.5	30.5				
	46	*g*	14.15	13.19	13.0	29.1	39.0	52.6		
	49	*h*	14.64	13.68	14.2	31.5	40.7			
	45	*j*	14.10	13.14	13.0	30.4	39.0			
	45''	*l*	14.62	13.67	13.4					
No. 2452	57'	*d*	14.78	13.83	17.1					
1893, Aug. 5	56'	*e*	13.93	12.97	16.5					
10^h34^m	54	*f*	14.57	13.61	17.3	27.0	40.3	54.9		
	58'	*g*	15.47	14.51	18.5					
	47''	*h*	13.29	12.33	15.6	24.6				
	62	*h*	14.66	13.70	17.6	26.8	40.2	55.8		
	59	*j*	13.63	12.67	17.1	25.6	38.3			
	59'	*j*	14.00	13.04	17.4	26.0				
No. 2465	71	*e*	14.58	13.62	9.8					
1893, Aug. 6	78'	*e*	14.71	13.75	9.8	23.3				
5^h10^m	60	*f*	14.01	13.06	9.5	22.9	35.3			
	61	*f*	14.14	13.18	9.3	22.3	36.4	48.0		
	64'	*f*	13.97	13.01	9.3					
	79	*f*	13.74	12.78	8.7	21.7				
	70	*g*	14.58	13.63	9.8					
	77	*g*	14.58	13.62	9.8					
	62'	*h*	13.65	12.69	9.1					
	79'	*h*	14.11	13.15	9.1	22.3				
	80	*h*	14.17	13.21	9.1	22.4				
	63'	*j*	13.93	12.97	8.9	22.0				
	65	*j*	14.07	13.11	9.1	22.2	36.2			
	69	*j*	13.40	12.44	8.7	20.6	34.5			
	74	*j*	14.66	13.70	8.8	22.3	37.9			
	67'	*l*	14.39	13.43	8.5	22.4	37.0	48.3		
	64	*n*	14.26	13.30	9.5	22.7	36.7			
	68	*g*	14.26	13.30	......	22.8	36.6			
No. 2471	49'	*h*	14.74	13.78	13.6	28.0				
1893, Aug. 7	50	*d*	15.08	14.12	13.5	28.8				
10^h27^m	66'	*j*	14.43	13.47	13.7	27.5				
	80'	*j*	14.03	13.07	12.8					
	75	*d*	14.03	13.07	13.0	26.7				
	78	*c*	14.33	13.38	12.9	27.3				
	83	*g*	13.97	13.01	12.6	26.9	38.1	......	64.1	
	84	*e*	15.27	14.31	12.9	28.0	42.4			
	80''	*h*	13.56	12.60	12.3					
	69'	*j*	14.18	13.22	12.9					
No. 2482	82	*c*	15.13	14.17	15.1					
1893, Aug. 8	77'	*g*	14.37	13.41	14.2	26.6				
9^h52^m	64''	*n*	13.91	12.95	13.8					
	89	*g*	13.81	12.85	13.3	25.5				
	90	*g*	13.88	12.92	13.8	25.4	......	51.2		
	92	*f*	14.67	13.71	13.7	27.2				
	94	*j*	14.12	13.16	14.0	25.9	......	52.0		
	95	*j*	14.08	13.12	13.8	25.9	......	51.8		
	96	*l*	14.33	13.37	14.9	26.7	......	52.9		
	97	*j*	13.91	12.95	13.7	26.0	......	......	......	78.6
	96'	*j*	14.42	13.46	14.2	26.2	......	53.2		

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 2496 1893, Aug. 9 11^h26^m	98	*a*	14.67°	13.71°	12.6					
	99	*f*	14.67	13.71	12.6					
	106	*a*	14.62	13.66	12.3	......	38.4	......	67.7	
	101	*g*	13.81	12.85	11.6	......	37.1			
	106′	*c*	14.40	13.44	12.3					
	104	*a*	13.56	12.60	10.4	......	36.3			
	108′	*g*	13.55	12.59	12.6	......	33.0	......	62.8	
	91	*a*	14.06	13.10	12.0					
	93′	*f*	13.65	12.69	11.6					
	97′	*j*	13.97	13.01	11.9					
	83′	*i*	13.65	12.69	11.6					
	90′	*i*	13.80	12.84	12.0	......	37.0			
	90″	*i*	13.87	12.91	11.8					
	103	*f*	13.97	13.01	11.9	......	39.0			
No. 2501 1893, Aug. 10 9^h23^m	102	*j*	14.00	13.04	......	24.8	......	53.1		
	107	*a*	13.80	12.84	......	25.3				
	87	*b*	14.66	13.70	......	27.0				
	108	*g*	13.42	12.46	......	24.6				
	118	*i*	13.62	12.66	......	24.2	......	52.0	......	80.0
	118′	*g*	13.57	12.61	......	25.6	......	51.3		
No. 2521 1893, Aug. 12 8^h47^m	109	*d*	14.52	13.56	......	28.5				
	110	*i*	14.18	13.22	......	28.1	......	57.2		
	111	*g*	14.40	13.44	......	28.2				
	112	*g*	13.89	12.93	......	27.2				
	113	*h*	13.89	12.93	......	27.2				
	114	*h*	14.10	13.14	......	27.6				
	115	*j*	14.04	13.08	......	27.5				
	89′	*i*	14.57	13.61	......	28.7				
	121′	*i*	14.25	13.29	......	28.0				
	102′	*j*	14.69	13.72	......	28.9				
	108″	*g*	15.27	14.31	......	30.1				
No. 2542 1893, Aug. 14 11^h5^m	116	*f*	14.11	13.15	......	29.2				
	124	*f*	14.14	13.18	......	28.2	38.9	52.2	65.9	
	133	*f*	14.31	13.35	......	29.7	40.1	52.8		
	132	*c*	13.70	12.74	......	28.1	37.9	50.4	63.1	
	135	*i*	13.91	12.95	......	28.7	38.7			
No. 2558 1893, Aug. 16 4^h33^m	129	*e*	14.10	13.14	10.1	22.7	35.9			
	137	*i*	14.57	13.61	10.2					
	138	*d*	14.58	13.62	10.6	24.0	37.9	......	66.9	79.3
	141	*f*	14.40	13.44	9.7	22.8	36.6			
	139	*i*	14.24	13.27	9.9	23.1				
	136	*h*	14.37	13.41	10.0	23.3				
	140	*i*	13.31	12.35	9.3	21.0	34.1			
	143	*g*	14.21	13.25	9.9					
	150	*h*	13.84	12.87	10.0	22.4				
	150′	*h*	14.54	13.57	9.7	23.4				
	134	*g*	14.29	13.32	10.0					
No. 2560 1893, Aug. 17 10^h38^m	142	*f*	14.63	13.66	13.5					
	151	*n*	13.96	13.00	12.8	26.9	......	54.5	62.6	
	152	*l*	13.10	12.14	12.0					
	153	*n*	14.10	13.14	11.8	26.0	......	55.0		

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 2560—*Cont'd.*	157	*n*	14.96°	14.00°	13.1	27.6				
	156	*h*	15.84	14.87	13.6	29.3				
	155	*h*	14.25	13.29	12.0	26.2				
	163	*f*	14.55	13.59	12.9	28.9	......	57.1	69.9	
	150''	*h*	13.23	12.26	12.1					
	160'	*j*	13.94	12.97	12.8					
No. 2569	145	*f*	12.78	12.81	12.5					
1893, Aug. 18	160	*j*	13.24	13.28	14.4	......	42.6			
10^h19^m	164'	*f*	15.01	14.05	14.4	......	45.0			
	168	*d*	14.64	13.68	14.5	......	43.8	57.3		
	168'	*d*	14.75	13.79	15.1	......	44.3	57.5		
	140'	*i*	14.76	13.80	13.5					
	171	*l*	14.05	13.09	14.1	......	41.8	54.9		
	171'	*l*	15.30	14.34	14.0					
	165'	*d*	14.52	13.56	14.1	......	43.5			
No. 2580										
1893, Aug. 19										
9^h51^m										
No. 2588	194	*l*	14.48	13.51	13.0					
1893, Aug. 21	165	*d*	14.06	13.10	12.6					
3^h13^m	170	*n*	13.23	12.26	11.8					
	174	*h*	15.11	14.15	13.6					
	175	*h*	13.86	12.90	12.4					
	176	*h*	14.15	13.19	12.7					
	180	*j*	13.86	12.90	12.4					
	181	*k*	13.55	12.59	12.1					
	183	*c*	13.55	12.59	12.1					
	184	*c*	15.45	14.49	13.9					
	185	*e*	13.99	13.02	12.5					
	186	*l*	13.60	12.64	12.2					
	187	*j*	14.48	13.51	13.0					
	188	*j*	13.55	12.59	12.1					
	189	*j*	14.06	13.10	12.6					
	190	*j*	13.73	12.77	12.3					
	191	*f*	14.36	13.40	12.9					
	197	*m*	13.55	12.59	12.1					
	195	*k*	13.33	12.36	11.9					
	196	*k*	13.46	12.50	12.0					
No. 2590										
1893, Aug. 22										
2^h25^m										
No. 2598	199	*k*	13.36	12.39	15.0					
1893, Aug. 28	200	*k*	13.07	12.11	15.1	24.1	38.0			
10^h59^m	206	*i*	13.93	12.96	16.0	25.9	40.6			
	208	*g*	14.40	13.43	16.2					
	209	*m*	13.82	12.85	15.5					
	211	*h*	14.40	13.43	16.2					
	212	*h*	14.50	13.53	16.3					
	213	*k*	13.49	12.52	15.1					
	214	*i*	14.44	13.47	16.4	26.9	42.1			
	215	*i*	14.25	13.28	16.3	26.3	41.7			
	217	*b*	15.12	14.15	17.1					
	219	*h*	14.21	13.24	16.2	27.1				

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 2617	220	*k*	13.37°	12.40°	9.6	23.4				
1893, Aug. 29	221	*k*	13.09	12.12	9.7	22.8				
4^h03^m	222	*k*	12.80	11.83	10.1	22.3				
	223	*e*	14.63	13.66	11.7	25.8				
	224	*i*	14.23	13.26	10.3	25.1				
	226	*h*	14.25	13.28	11.0	24.7	36.8	49.4	......	77.0
No. 2619	225	*b*	13.88	12.91	13.6					
1893, Aug. 30	228	*d*	14.46	13.49	14.2					
12^h03^m	230	*b*	12.37	11.40	12.5	22.1				
	231	*i*	15.65	14.68	15.5					
	232	*d*	14.72	13.75	14.6	26.6	39.8			
	235	*f+h*	14.36	13.39	14.4	26.0				
	236	*g*	14.72	13.75	14.5	26.7				
	237	*j*	14.18	13.21	13.5	25.8	......	......	65.2	
	238	*h*	14.19	13.22	14.3	25.9	......	......	65.2	
	240	*g*	14.87	13.90	15.3	27.0				
	242	*d*	14.48	13.51	13.7	25.7	39.0			
	233	*e*	14.82	13.85	14.6					
No. 2628	241	*g*	14.77	13.80	12.2	25.0				
1893, Aug. 31	239	*h+j*	14.74	13.77	12.1					
1^h28^m	245	*h*	14.78	13.81	12.3	25.3				
	246	*j*	14.43	13.46	11.1	23.9	......	52.1		
	247	*h*	14.49	13.52	11.1	24.5				
	248	*f*	14.96	13.99	11.0	24.0	......	50.4	......	75.9
	249	*f*	12.98	12.01	10.6					
	250	*l*	13.96	12.99	14.8	23.8				
	251	*f*	14.33	13.36	11.7	24.5	......	50.6		
	252	*e*	14.61	13.64	12.0	24.7				
	253	*e*	14.15	13.18	12.1	24.7	......	51.0		
	254	*g*	13.73	12.76	11.1	23.1				
	255	*l*	14.29	13.32	11.2	24.2				
	256	*h*	13.84	12.87	9.7	22.4	......	49.7		
No. 2634	257	*h*	14.94	13.97	13.2					
1893, Sept. 1	258	*d*	14.87	13.90	13.1					
10^h41^m	259	*d*	14.42	13.45	12.7					
	260	*f*	15.32	14.35	13.5					
	261	*d*	15.03	14.06	13.3					
	262	*h*	15.79	14.82	14.0					
	263	*f*	15.32	14.35	13.5					
	264	*b*	15.18	14.21	13.4					
	265	*f*	14.06	13.09	12.4					
	266	*h*	15.71	14.74	13.9					
	267	*j*	14.69	13.72	13.0	......	40.9			
	268	*e*	14.79	13.82	13.0	......	41.2			
	269	*j*	13.86	12.89	12.2					
	270	*j*	14.32	13.35	13.2	......	39.8			
	271	*h*	13.86	12.89	12.2					
No. 2639	244′	*g*	13.68	12.71	......	25.8				
1893, Sept. 2	273	*g*	14.01	13.04	......	26.0	......	52.5		
9^h18^m	275	*i*	13.66	12.69	......	25.4	......	51.1		
	276	*h*	14.08	13.11	......	26.7	......	53.6	68.2	
	278	*j*	14.19	13.22	......	26.9				

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 2639—*Cont'd.*	279	*j*	14.52°	13.55°	......	27.5				
	280	*h*	14.08	13.11	......	26.8	......	54.4	69.3	
	281	*g*	13.72	12.75	......	25.7	......	50.6	65.5	
No. 2651	274	*j*	14.67	13.70	......	27.2				
1893, Sept. 4	283	*h*	14.42	13.45	......	27.0	41.6			
10^h12^m	284	*h*	13.63	12.66	......	25.6	39.2			
	288	*m*	14.57	13.60	......	26.9				
	290	*h*	14.58	13.61	......	27.0				
	291	*k*	14.57	13.60	......	26.9				
	292	*h*	14.58	13.61	......	27.0				
	293	*l*	14.98	14.01	......	27.8				
	294	*l*	14.73	13.76	......	27.3				
	297	*f*	14.69	13.72	......	27.9	42.4			
	298	*f*	14.88	13.91	......	28.0	43.0			
	301	*g*	14.38	13.41	......	27.0	42.7	55.9		
	302	*a*	14.57	13.60	......	26.9				
	304	*d+f*	13.62	12.65	......	27.7	39.1			
	305	*f*	14.42	13.45	......	27.4	41.6			
	306	*g*	14.13	13.16	......	25.7	40.7			
No. 2675	310	*h*	14.02	13.05	14.4					
1893, Sept. 6	311	*f*	13.84	12.87	14.2					
9^h47^m	314	*d*	14.41	13.44	14.8					
	315	*b*	15.84	14.87	16.4					
	316	*d*	14.12	13.15	14.5					
	319	*g*	14.67	13.70	15.1					
	320	*g*	15.21	14.24	15.7					
	326	*f*	13.74	12.77	14.1					
No. 2681	289	*e*	14.12	13.15	15.3	......	......	53.0		
1893, Sept. 7	329	*k*	14.09	13.12	14.9	......	......	52.9		
12^h19^m	330	*f*	15.26	14.29	15.4					
	331	*h*	14.04	13.07	15.1	......	......	52.7		
	332	*j*	14.64	13.67	14.7					
	333	*h*	14.92	13.95	15.0					
	334	*k*	14.07	13.10	14.1					
	335	*k*	13.14	12.17	13.1					
	336	*i*	14.07	13.10	14.1					
	337	*i*	13.56	12.59	13.5					
	338	*g*	14.34	13.37	14.4					
	339	*g*	14.28	13.31	14.6	......	......	53.7		
	340	*i*	12.94	11.97	12.9					
No. 2694	344	*e*	14.06	13.09	......	......	38.5			
1893, Sept. 8	345	*h*	13.66	12.69	......	......	37.3			
2^h12^m	346	*h*	14.06	13.09	......	......	38.5			
	347	*d*	14.06	13.09	......	......	38.5			
No. 2699	353	*f*	14.26	13.29	......	......	40.1	52.2		
1893, Sept. 11	354	*f*	14.61	13.64	......	......	40.3			
12^h48^m	355	*f*	14.52	13.55	......	......	40.0			
	356	*d*	15.19	14.22	......	......	42.0			
	357	*d*	14.13	13.16	......	......	38.8	53.2		
	358	*d*	14.16	13.19	......	......	38.5	53.1		
	360	*f*	14.44	13.47	......	......	39.8			

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 2712 1893, Sept. 14 11h42m	361	*b*	14.30°	13.32°	13.9					
	362	*d*	14.30	13.32	13.9					
	363	*d*	14.20	13.22	13.8					
	364	*d*	14.39	13.41	14.0					
	365	*d*	13.69	12.71	13.3					
	367	*f*	14.39	13.41	14.0					
	368	*f*	13.15	12.17	12.7					
	372	*f*	14.77	13.79	14.4					
	373	*f*	15.17	14.19	14.8					
	374	*f*	14.67	13.69	14.3					
	375	*i*	13.81	12.83	13.4					
	376	*i*	14.59	13.61	14.2					
	377	*i*	14.59	13.61	14.2					
	380	*g*	13.15	12.17	12.7					
	381	*c*	15.84	14.86	15.5					
	382	*c*	14.30	13.32	13.9					
	383	*i*	14.67	13.69	14.3					
	384	*i*	13.81	12.83	13.4					
	386	*c*	13.69	12.71	13.3					
	387	*d*	13.52	12.54	13.1					
	388	*l*	11.53	10.55	11.0					
	389	*i*	13.90	12.92	13.5					
	391	*h*	13.42	12.44	13.0					
	392	*j*	12.53	11.55	12.1					
	393	*h*	13.24	12.26	12.8					
	394	*d*	13.69	12.71	13.3					
No. 2722 1893, Sept. 15 12h49m										
No. 2741 1893, Sept. 22 11h13m	405	*e*	14.89	13.91	14.3					
	406	*e*	14.98	14.00	14.4					
	407	*c*	14.98	14.00	14.4					
	410	*a*	14.34	13.36	13.7					
	411	*a*	14.79	13.81	14.2					
	412	*e*	15.28	14.30	14.7					
	414	*e*	14.70	13.72	14.1					
	415	*c*	14.60	13.62	14.0					
	417	*d*	14.44	13.46	13.8					
	418	*d*	15.08	14.10	14.5					
	420	*f*	14.60	13.62	14.0					
	422	*c*	14.79	13.81	14.2					
	429	*e*	14.51	13.53	13.9					
	428	*e*	15.38	14.40	14.8					
No. 2756 1893, Sept. 23 11h53m										
No. 2777 1893, Oct. 4 9h16m	447	*c*	14.07	13.08	14.0	......	39.7			
	448	*c*	14.22	13.23	13.8					
	450	*c*	14.42	13.43	14.0					
	451	*c*	14.78	13.79	14.4					
	452	*c*	14.42	13.43	14.0					
	455	*a*	15.05	14.06	14.7					
	456	*c*	14.76	13.77	13.9	......	42.2			
	457	*d*	13.54	12.55	13.1					

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 2777—*Cont'd.*	458	*b*	14.09°	13.10°	13.7	......	39.9			
	459	*d*	14.03	13.04	13.4	......	39.9			
	461	*d*	14.31	13.32	13.9					
	462	*j*	14.43	13.44	13.7	......	41.1			
	463	*j*	14.22	13.23	13.8					
	464	*n*	13.81	12.82	13.4					
	465	*l*	13.81	12.82	13.4					
	466	*n*	12.76	11.77	12.3					
	467	*f*	14.13	13.14	13.7					
	468	*d+f*	13.81	12.82	13.4					
	469	*d*	13.54	12.55	13.1					
	471	*l*	14.09	13.10	13.6					
	472	*a*	14.31	13.32	13.9					
	473	*h*	14.67	13.68	14.3					
	474	*f*	14.13	13.14	13.7					
No. 2787 1893, Oct. 5 $10^h 22^m$	470	*a*	14.90	13.91	......	27.9				
	477	*a*	14.48	13.49	......	27.0				
No. 2791	481	*h*	14.56	13.57	......	26.1	39.8			
1893, Oct. 7	482	*h*	14.54	13.55	......	25.5	40.5			
$10^h 26^m$	483	*f*	13.97	12.98	......	25.7	39.7	......	65.5	
	484	*f*	13.87	12.88	......	25.3	39.0	......	65.3	
	485	*f*	13.84	12.85	......	25.1	39.2	55.6	65.4	
	486	*f*	14.27	13.28	......	25.2	39.6			
	487	*d*	14.52	13.53	......	25.8				
	488	*d*	14.52	13.53	......	25.9	39.8			
	489	*b*	14.52	13.52	......	25.7	40.2			
	490	*h*	14.57	13.58	......	26.0	40.1			
	491	*a*	14.46	13.47	......	25.3	40.3			
	492	*g*	14.59	13.60	......	25.9				
	495	*i*	14.10	13.11	......	25.4	38.2			
No. 2797	493	*g*	14.68	13.69	14.4					
1893, Oct. 9	494	*g*	14.68	13.69	14.4					
$8^h 10^m$	497	*g*	14.46	13.47	14.2					
	498	*i*	13.89	12.90	13.6					
	499	*e*	13.54	12.55	13.2					
	500	*f*	14.43	13.44	14.3	31.6	42.0			
	501	*f*	14.63	13.64	16.0	33.2	42.8			
	502	*j*	14.35	13.36	14.1					
	503	*j*	14.55	13.56	14.3					
	504	*l*	15.34	14.35	15.1					
	505	*f*	15.34	14.35	15.1					
	506	*g*	13.72	12.73	13.4					
	507	*a*	14.20	13.21	13.9					
	508	*l*	14.02	13.03	13.7					
No. 2800	509	*g*	13.56	12.57	15.2	25.0				
1893, Oct. 10	510	*g*	13.65	12.66	15.4	25.3				
$9^h 28^m$	512	*f*	14.50	13.51	17.2	27.0				
	513	*h*	13.85	12.86	16.8	25.7				
	514	*d*	14.50	13.51	16.9	27.0				
	515	*f*	14.39	13.40	16.9	26.8				
	516	*f*	13.80	12.81	16.9	25.6				

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 2800—*Cont'd.*	517	*m*	13.40°	12.41°	14.1	24.8				
	517′	*k*	12.75	11.76	15.2					
	522	*d*	15.10	14.11	18.6	28.2				
	525	*h*	14.14	13.15	17.2	26.3				
No. 2809 1893, Oct. 11 4^h05^m	519	*f*	14.09	13.10	9.5					
	520	*d*	14.24	13.25	9.6					
	523	*f*	12.99	12.00	8.7					
	524	*f*	13.98	12.99	9.4					
	528	*h*	14.09	13.10	9.5					
	529	*h*	13.67	12.68	9.2					
No. 2812 1893, Oct. 12 9^h26^m										
No. 2818 1893, Oct. 16 10^h30^m	530	*d*	14.87	13.88	14.3	27.5				
	531	*d*	14.60	13.61	14.2	27.0				
	532	*k*	14.27	13.28	13.9	26.4	39.3			
	533	*f*	14.05	13.06	14.0	25.9				
	534	*h*	14.39	13.40	13.9	26.6				
	535	*f*	14.70	13.71	14.2					
	536	*j*	14.39	13.40	13.9					
	537	*l*	14.30	13.31	14.3	26.4				
	538	*l*	14.10	13.11	13.6					
	539	*k*	14.10	13.11	13.6	26.4	38.8			
	541	*i*	13.71	12.72	13.2	24.9	37.6			
	543	*j*	14.39	13.40	13.7	26.6				
	544	*l*	13.98	12.99	13.4	25.8				
	545	*l*	14.79	13.80	14.6	27.4				
	546	*l*	13.29	12.30	12.6	24.4				
	548	*e*	15.27	14.28	14.8					
	549	*i*	14.35	13.36	14.1	26.8	39.6			
	550	*k*	13.73	12.74	13.2					
	552	*c*	15.01	14.02	14.9	27.8				
	553	*a*	14.99	14.00	14.5					
	554	*a*	15.48	14.49	15.0					
	556	*h*	14.34	13.35	14.8	27.0	40.0			
No. 2821 1893, Oct. 17 11^h25^m	540	*i*	13.91	12.92	12.5	24.8				
	542	*k*	13.81	12.82	12.9	24.6				
	559	*e*	15.29	14.30	13.5					
	560	*f*	14.60	13.61	12.8	26.2	……	55.4		
	561	*h*	13.86	12.87	12.8	24.7				
	562	*h*	14.62	13.63	12.8					
	563	*h*	13.55	12.56	13.2	26.3	……	52.1		
	565	*g*	14.27	13.28	12.5					
	566	*g*	13.95	12.96	12.2					
	567	*e*	13.56	12.57	12.0	24.1				
	568	*f*	14.41	13.42	12.6	26.3	……	55.0		
	555	*f*	14.01	13.02	12.4	25.6	……	53.5		
No. 2829 1893, Oct. 18 10^h03^m	569	*m*	13.43	12.44	12.1					
	570	*g*	13.93	12.94	12.5	……	41.3			
	571	*c*	13.97	12.98	13.6					
	572	*c*	14.34	13.35	13.0					

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	5	5	6
No. 2829 —*Cont'd.*	573	*h*	14.88°	13.89°	13.5					
	574	*f*	14.09	13.10	12.5	......	41.9			
	575	*k*	13.24	12.25	11.9					
No. 2831	577	*c*	14.24	13.25	......	29.3				
1893, Oct. 19	578	*c*	14.24	13.25	......	29.3				
9^h27^m	581	*e*	14.24	13.25	......	29.3				
	582	*i*	15.79	14.80	......	32.7				
No. 2839										
1893, Oct. 21										
2^h29^m										
No. 2870	583	*h*	13.31	12.31	12.5					
1893, Nov. 6	584	*h*	14.51	13.51	13.7					
10^h51^m	585	*f*	15.70	14.70	14.9					
	586	*f*	14.01	13.00	13.5	......	39.0			
	587	*f*	14.08	13.07	13.8	......	39.1			
	588	*a*	13.84	12.84	13.0					
	589	*f*	15.39	14.39	14.6					
	590	*h*	14.33	13.33	13.5					
	591	*j*	14.56	13.55	13.6	......	40.9			
	592	*f*	14.45	13.44	13.5	......	40.4			
	594	*h*	13.93	12.93	13.1					
	596	*f*	14.80	13.80	14.1					
No. 2877	597	*j*	14.15	13.14	......	26.1				
1893, Nov. 7	598	*j*	14.50	13.49	......	26.8				
11^h14^m	607	*h*	14.50	13.49	......	26.8				
	608	*a*	14.70	13.69	......	27.2				
No. 2880	603	*h*	14.61	13.60	14.0					
1893, Nov. 9	604	*j*	13.13	12.12	12.5					
10^h53^m	605	*j*	12.36	11.35	11.7					
	606	*j*	14.40	13.39	13.8					
	610	*n*	14.29	13.28	13.7					
	611	*h*	14.10	13.09	13.5					
No. 2888										
1893, Nov. 10										
11^h35^m										
No. 2898	612	*i*	14.56	13.55	13.4					
1893, Nov. 17	613	*g*	13.96	12.95	12.8					
11^h26^m	614	*g*	14.27	13.26	13.1					
	615	*d*	14.56	13.55	13.4					
	616	*l*	13.56	12.55	12.4					
	617	*l*	13.56	12.55	12.4					
	621	*i*	14.77	13.76	13.6					
	622	*p*	12.13	11.12	11.0					
	626	*n*	12.84	11.83	11.7					
	631	*d*	14.06	13.05	12.9					
No. 2904										
1893, Nov. 18										
11^h12^m										

TABLE 1. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3020 1894, Jan. 25 12^h24^m	632	*f*	14.19°	13.17°	12.7					
	633	*f*	14.09	13.07	12.6					
	634	*d*	13.98	12.96	12.5					
	635	*d*	13.89	12.87	12.4					
	636	*f*	14.09	13.07	12.6					
	637	*h*	13.79	12.77	12.3					
	639	*f*	14.19	13.17	12.7					
	640	*f*	14.40	13.38	12.9					
	641	*e*	13.57	12.55	12.1					
	642	*g*	14.09	13.07	12.6					
	644	*d*	13.69	12.67	12.2					
	648	*j*	14.51	13.49	13.0					
	650	*f*	13.79	12.77	12.3					
	651	*l*	13.79	12.77	12.3					
	652	*l*	13.57	12.55	12.1					
	653	*n*	13.98	12.96	12.5					
No. 3028 1894, Jan. 26 11^h32^m										
No. 3062 1894, Feb. 27 1^h33^m	654	*f*	14.70	13.70	13.7					
	655	*h*	14.30	13.30	13.3					
	656	*j*	14.40	13.40	13.4					
	657	*j*	14.90	13.90	13.9					
	658	*h*	14.50	13.50	13.5					
	659	*l*	13.80	12.80	12.8					
	660	*l*	14.30	13.30	13.3					
	661	*j*	14.00	13.00	13.0					
	662	*j*	14.30	13.30	13.3					
	663	*j*	13.90	12.90	12.9					
	664	*j*	14.30	13.30	13.3					
	665	*j*	13.90	12.90	12.9					
	666	*j*	13.90	12.90	12.9					
	667	*j*	14.40	13.40	13.4					
	668	*h*	14.80	13.80	13.8					
	669	*f*	14.80	13.80	13.8					
	670	*c*	14.70	13.70	13.7					
	671	*a*	13.80	12.80	12.8					
	672	*b*	14.80	13.80	13.8					
	673	*b*	13.80	12.80	12.8					
	674	*a*	14.70	13.70	13.7					
	675	*e*	13.70	12.70	12.7					
	676	*i*	15.10	14.10	14.1					
	677	*d*	15.00	14.00	14.0					
	678	*f*	14.80	13.80	13.8					
No. 3069 1894, Feb. 28 1^h33^m	679	*h*	14.71	13.71	......	28.4	40.3			
	680	*h*	14.52	13.52	......	27.9				
	681	*h*	13.93	12.93	......	26.5	38.4			
	682	*f*	14.22	13.22	......	27.3	38.8			
	683	*h*	14.13	13.13	......	27.0	38.8			
	684	*h*	15.14	14.14	......	29.2				
	685	*k*	14.35	13.35	......	27.5				
	686	*m*	13.88	12.88	......	26.6				
	687	*k*	14.43	13.43	......	27.7				

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3079	689	*h*	15.29°	14.29°	12.5					
1894, Mar. 2	690	*f*	15.06	14.06	12.3					
3^h10^m	691	*j*	14.71	13.71	12.0					
	692	*j*	14.37	13.37	11.7					
	693	*c*	14.37	13.37	11.7					
	694	*e*	14.03	13.03	11.4					
	695	*e*	14.60	13.60	11.9					
	696	*i*	14.14	13.14	11.5					
	697	*i*	14.26	13.26	11.6					
	698	*k*	14.03	13.03	11.4					
No. 3082										
1894, Mar. 3										
12^h10^m										
No. 3093	699	*e*	14.54	13.54	......	28.4				
1894, Mar. 8	700	*g*	14.35	13.35	......	28.0				
11^h45^m	702	*c*	14.64	13.64	......	28.6				
	703	*c*	14.40	13.40	......	28.1				
	704	*c*	14.49	13.49	......	28.3				
	705	*f*	14.49	13.49	......	28.3				
	706	*j*	14.35	13.35	......	28.0				
	707	*l*	14.88	13.88	......	29.1				
	709	*f*	14.49	13.49	......	28.3				
	710	*f*	14.49	13.49	......	28.3				
	711	*f*	14.30	13.30	......	27.9				
	712	*f*	14.69	13.69	......	28.7				
	713	*f*	14.64	13.64	......	28.6				
	714	*f*	14.35	13.35	......	28.0				
	715	*h*	14.30	13.30	......	27.9				
	716	*h*	14.35	13.35	......	28.0				
	717	*j*	14.40	13.40	......	28.1				
	718	*h*	14.68	13.68	......	28.7				
	719	*b*	14.40	13.40	......	28.1	......	......	68.8	
No. 3101										
1894, Mar. 10										
2^h04^m										
No. 3104	721	*c*	12.91	11.91	11.8					
1894, Mar. 13	722	*c*	13.51	12.51	12.4					
2^h12^m	723	*g*	14.22	13.22	13.1					
	724	*e*	13.92	12.92	12.8					
	725	*e*	14.02	13.02	12.9	25.6	39.6	51.1		
	726	*c*	14.49	13.49	13.4	26.4				
	727	*e*	14.42	13.42	13.3					
	728	*g*	13.92	12.92	12.8					
	729	*g*	13.31	12.31	12.2					
	730	*g*	13.89	12.89	12.8	25.7	38.8			
	733	*b+d*	14.62	13.62	13.5					
	736	*g*	14.32	13.32	13.2					
	741	*f*	14.02	13.02	12.9					
No. 3106	731	*a*	15.06	14.06	13.6					
1894, Mar. 14	732	*b*	14.24	13.24	13.6	26.9				
1^h59^m	734	*h*	14.13	13.13	12.7					
	737	*e*	14.20	13.20	12.7	26.2	38.7			
	738	*e*	13.51	12.51	12.1					

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3106—*Cont'd.*	739	*e*	14.23°	13.23°	12.8					
	740	*c*	14.50	13.50	13.2	27.4				
	743	*a*	14.95	13.95	13.5					
	748	*d*	14.98	13.98	13.1	28.0	40.8			
No. 3112	744	*d*	14.87	13.88	14.7	27.1				
1894, Mar. 15	745	*d*	14.20	13.21	13.8	25.8				
1^h12^m	746	*d*	15.12	14.13	15.4	27.6				
	747	*f*	15.17	14.18	15.4	27.7				
	749	*b*	14.71	13.72	14.6					
No. 3117	750	*d*	15.39	14.40	12.8					
1894, Mar. 16	751	*b*	14.60	13.61	12.1					
2^h44^m	752	*h*	13.81	12.82	11.4					
	753	*h*	14.38	13.39	11.9					
	754	*f*	15.39	14.40	12.8					
	755	*h*	14.60	13.61	12.1					
	756	*i*	14.72	13.73	12.2					
	757	*i*	14.60	13.61	12.1					
	758	*c*	13.25	12.26	10.9					
	759	*g*	14.60	13.61	12.1					
	760	*c*	14.15	13.16	11.7					
No. 3121										
1894, Mar. 17										
12^h04^m										
No. 3185	761	*a*	14.30	13.34	13.7					
1894, May 30	762	*c*	14.98	14.02	14.4					
3^h16^m	763	*i*	14.59	13.63	14.0					
	764	*e*	14.98	14.02	14.4					
	765	*e*	14.20	13.24	13.6					
	766	*g*	14.78	13.82	14.2					
	767	*e*	14.20	13.24	13.6					
	768	*c*	14.30	13.34	13.7					
	769	*f*	14.49	13.53	13.9					
	770	*l*	13.60	12.64	14.2	24.2				
	771	*f*	14.69	13.73	14.1					
	773	*d*	14.49	13.53	13.9					
	774	*f*	14.48	13.52	14.7	25.9				
	775	*f*	13.96	13.00	14.2	24.9				
	776	*c*	14.10	13.14	13.5					
	777	*i*	13.38	12.42	14.0	23.8				
	778	*g*	14.40	13.44	13.8					
	779	*c*	14.59	13.63	14.0					
	780	*e*	14.49	13.53	13.9					
No. 3190										
1894, May 31										
3^h55^m										
No. 3191	781	*e*	14.41	13.45	......	24.8				
1894, June 2	782	*e*	14.20	13.24	......	24.5				
1^h09^m	783	*e*	14.30	13.34	......	24.6				
	784	*c*	14.53	13.57	......	25.0	40.6	53.8		
	785	*a*	14.34	13.38	......	23.7	39.2	53.1		
	786	*e*	14.52	13.56	......	25.0				
	787	*g*	14.30	13.34	......	24.6				

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3191—*Cont'd.*	788	*g*	14.41°	13.45°	......	24.8				
	789	*g*	13.65	12.69	......	23.4				
	790	*e*	13.87	12.91	......	23.8				
	791	*i*	14.03	13.07	......	24.1				
No. 3196	792	*d*	14.57	13.61	15.9	28.9				
1894, June 4	793	*b*	15.13	14.17	15.6	30.1				
9^h25^m	794	*g*	13.93	12.97	14.8					
	795	*d*	14.27	13.31	15.3	28.3				
No. 3201	797	*g*	14.31	13.35	13.1					
1894, June 5	798	*e*	14.21	13.25	13.0					
12^h53^m	800	*m*	13.60	12.64	12.4					
	801	*o*	13.29	12.33	12.1					
	802	*m*	13.60	12.64	12.4					
	803	*i+k*	14.21	13.25	13.0					
	804	*j*	14.00	13.04	12.8					
	805	*d*	14.21	13.25	13.0					
	806	*i*	14.11	13.15	12.9					
	807	*e*	14.51	13.55	13.3					
	808	*g*	13.60	12.64	12.4					
	809	*g*	13.19	12.23	12.0					
	810	*g*	14.11	13.15	12.9					
No. 3204										
1894, June 6										
12^h26^m										
No. 3207	813	*f*	14.92	13.96	14.9					
1894, June 11	815	*f*	13.61	12.65	13.5					
12^h58^m	816	*f*	14.54	13.58	14.5					
	817	*f*	14.36	13.40	14.3					
	818	*f*	15.01	14.05	15.0					
	819	*f*	14.45	13.49	14.1	27.6				
	819′	*a*	14.64	13.68	14.6					
	820	*a*	14.92	13.96	14.9					
	821	*a*	14.35	13.39	14.3	27.4				
	822	*c*	14.64	13.68	14.6					
	823	*c*	14.82	13.86	14.8					
	824	*e*	14.45	13.49	14.4					
	825	*c*	14.36	13.40	14.3					
	826	*c*	14.45	13.49	14.4					
	827	*a*	14.59	13.63	14.7	27.9				
	828	*b*	14.73	13.77	14.7					
	829	*d*	15.11	14.15	15.1					
	830	*f*	14.35	13.39	14.5	27.4				
	831	*h*	14.35	13.39	14.2	27.4				
	832	*f*	14.87	13.91	14.8	28.5				
	833	*f*	14.36	13.41	14.2	27.2	......	53.6	68.2	
	834	*h*	14.36	13.40	14.3					
	835	*h*	14.64	13.68	14.6					
	836	*j*	14.45	13.50	14.3	27.5	......	53.2		
	837	*h*	14.57	13.62	15.2	27.9	......	53.7		
	838	*h*	14.39	13.44	14.0	27.6	......	53.9	69.2	
	839	*f*	14.43	13.47	14.2	27.6				
	840	*f*	14.65	13.69	14.3	28.0				
	840′	*f*	15.01	14.05	15.0					

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3207—*Cont'd.*	844	*f*	14.86°	13.90°	15.3	28.5				
	847	*j*	14.64	13.68	14.6					
	822′	*c*	14.73	13.77	14.7					
No. 3211	841	*d*	14.82	13.87	13.8	......	39.8			
1894, June 12	842	*a*	15.00	14.05	13.6	......	39.7	56.2		
2^h35^m	843	*c*	14.70	13.75	13.7	......	39.1	55.1		
	845	*f*	14.32	13.36	13.1					
	846	*f*	14.73	13.77	13.5					
	848	*f*	14.42	13.46	13.2					
	849	*h*	14.57	13.62	13.5	......	39.3			
No. 3214	850	*b*	15.34	14.39	......	27.2				
1894, June 13	851	*f*	14.48	13.53	......	25.9	41.8			
2^h07^m	852	*f*	14.51	13.56	......	25.4	41.0			
	853	*a*	14.75	13.80	......	25.6	41.8			
	855	*h*	14.27	13.32	......	25.0	40.4			
	856	*j*	14.17	13.22	......	25.0	40.0			
No. 3216	857	*l*	14.52	13.57	15.4					
1894, June 15	858	*j*	14.34	13.39	15.2					
11^h28^m	859	*j*	14.70	13.75	15.6					
	860	*f*	14.87	13.92	15.8					
	861	*c*	14.52	13.57	15.4					
	862	*c*	15.14	14.19	16.1					
	863	*g*	14.56	13.61	14.3	......	43.6			
	864	*h*	15.23	14.28	16.2					
	865	*j*	14.17	13.22	15.0					
	866	*d*	15.05	14.10	16.0					
	867	*h*	15.14	14.19	16.1					
	868	*f*	14.87	13.92	15.8					
	869	*e*	14.26	13.31	15.1					
	870	*h*	14.37	13.43	14.9	......	43.2	53.0		
	871	*e*	14.61	13.66	15.5					
	872	*c*	13.99	13.04	14.8					
No. 3218	873	*c*	14.17	13.22	......	27.2	37.1			
1894, June 16	874	*e*	14.30	13.35	......	28.4	37.7	53.4	63.7	
2^h42^m	875	*f*	13.87	12.92	......	28.0	36.5	51.4		
	876	*d*	14.15	13.20	......	27.1	37.1			
	877	*a*	14.49	13.54	......	26.8	38.3			
No. 3221	878	*d*	13.80	12.85	9.2					
1894, June 18	879	*b*	15.20	14.25	10.2					
4^h45^m	880	*b*	14.64	13.69	9.8					
	881	*b*	14.50	13.55	9.7					
	882	*b*	14.78	13.83	9.9					
	883	*d*	15.20	14.25	10.2					
	884	*f*	14.92	13.97	10.0					
	885	*f*	14.08	13.13	9.4					
	886	*f*	15.06	14.11	10.1					
	887	*h*	14.65	13.70	9.7	25.9				
	888	*j*	14.50	13.55	9.7					
	889	*j*	14.22	13.27	9.5					
	891	*c*	14.28	13.33	9.5	25.2				
	892	*f*	13.80	12.85	9.2					
	893	*f*	14.43	13.48	9.6	25.5				

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3223	890	*h*	14.40°	13.45°	15.7	26.4	40.5	54.4		
1894, June 19	894	*d*	14.43	13.48	16.2	26.5				
9h56m	895	*e*	14.58	13.63	16.0					
No. 3228	896	*d*	14.54	13.59	10.8	24.9				
1894, June 20	897	*b*	14.92	13.97	10.7	25.6				
2h07m	898	*a*	14.59	13.64	10.9	25.0				
	899	*a*	14.21	13.26	10.3	24.3				
	900	*g*+*i*	14.01	14.06	11.1					
	901	*e*	14.25	13.30	10.5					
	902	*e*	14.25	13.30	10.5					
	903	*c*	14.76	13.81	10.6	25.3				
	904	*c*	14.44	13.49	10.1	24.5	38.6			
	905	*g*	14.75	13.80	10.9					
	906	*g*	15.26	14.31	11.3					
	908	*i*	13.61	12.66	10.0					
	909	*k*	13.69	12.74	10.0	23.1	36.6			
	912	*c*	14.47	13.52	10.2	24.7	38.6			
	913	*g*	13.74	12.79	10.1					
	915	*e*	13.99	13.04	10.3					
	916	*e*	14.75	13.80	10.9					
	917	*f*	14.88	13.93	11.0					
No. 3232	918	*b*	14.19	13.24	13.7	27.5				
1894, June 21	919	*e*	14.75	13.80	14.4					
9h04m	920	*c*	13.90	12.95	13.2	26.9				
	921	*c*	14.57	13.62	14.3	28.3				
	922	*c*	14.29	13.34	14.0	27.7				
No. 3239	924	*b*	15.38	14.43	14.9					
1894, June 22	925	*b*	14.99	14.04	14.5					
10h07m	926	*i*	14.31	13.36	13.8					
	927	*k*	14.22	13.27	13.7					
	928	*c*	14.25	13.30	14.1	......	39.5			
	929	*e*	13.70	12.75	13.2					
No. 3241	934	*b*	14.56	13.61	......	26.6	......	53.9		
1894, June 23	935	*e*	14.40	13.45	......	25.9	......	53.3		
10h54m										
No. 3245	936	*a*	14.91	13.96	......	28.0				
1894, June 25	937	*e*	14.31	13.36	......	26.8				
9h44m	938	*g*	14.46	13.51	......	27.2	44.1			
	939	*g*	14.50	13.55	......	28.0	44.1			
	940	*g*	14.08	13.13	......	27.0	43.3	52.4		
No. 3247	941	*i*	14.60	13.65	17.2	27.3				
1894, June 27	942	*i*	14.95	14.00	16.7	28.0				
9h53m	943	*d*	15.00	14.05	17.8	28.1				
	944	*f*	15.10	14.15	17.9	28.3				
	945	*b*	14.95	14.00	17.5	28.0				
No. 3253	936′	*a*	14.54	13.59	10.1					
1894, June 28	946	*f*	14.14	13.19	9.8					
4h05m	947	*c*	14.27	13.32	9.9					
	948	*c*	13.46	12.51	9.3					
	949	*c*	14.95	14.00	10.4					

TABLE 1. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3253—*Cont'd.*	950	*e*	13.87°	12.92°	9.6					
	951	*g*	14.95	14.00	10.4					
	952	*g*	14.95	14.00	10.4					
	953	*a*	14.41	13.46	10.0					
	954	*b*	14.54	13.59	10.1					
	955	*b*	14.14	13.19	9.8					
	963	*c*	12.79	11.84	8.8					
	964	*d*	15.48	14.53	10.8					
	965	*h*	13.73	12.78	9.5					
No. 3258 1894, June 29 9^h55^m										
No. 3265	966	*f*	14.75	13.80	16.6	27.0				
1894, July 2	967	*f*	14.56	13.61	16.5					
10^h12^m	968	*f*	14.39	13.44	16.3	26.3				
	969	*d*	14.23	13.28	16.1					
	970	*a*	14.15	13.20	16.0					
	971	*b*	14.19	13.24	16.1	25.9				
	972	*a*	13.82	12.87	15.6					
	973	*b*	14.86	13.91	16.8	27.2				
	974	*b*	15.71	14.76	17.9					
	975	*b*	14.65	13.70	17.9	27.8	44.3			
	976	*b*	14.75	13.80	16.7	27.0				
No. 3272	977	*a*	14.39	13.44	11.0	27.0				
1894, July 3	978	*a*	15.20	14.25	10.6					
3^h18^m	979	*g*	13.32	12.37	9.2					
	980	*i*	13.84	12.89	9.6	25.9				
	981	*f*	13.99	13.04	9.7					
	982	*c*	14.70	13.75	10.5	27.6				
	984	*c*	14.34	13.39	9.8	26.9				
	985	*a*	15.09	14.14	10.7	28.4				
	986	*f*	14.65	13.70	10.0	27.8	41.6			
	987	*a*	15.07	14.12	10.5					
No. 3279 1894, July 4 9^h09^m	988	*a*	14.55	13.60	17.2					
No. 3284	990	*d*	14.64	13.69	13.0	27.6				
1894, July 5	991	*f*	14.35	13.40	12.8	27.1	......	53.0		
3^h30^m	992	*f*	14.38	13.43	12.9	27.1				
	993	*f*	14.34	13.39	13.1	27.0				
	994	*f*	14.20	13.25	13.0	26.7				
	995	*f*	14.14	13.19	12.6	26.6				
	996	*c*	14.38	13.43	12.5	27.1				
No. 3286	1001	*f*	14.89	13.94	14.9					
1894, July 6	1002	*h*	14.52	13.57	14.5					
2^h15^m	1003	*f*	13.96	13.01	13.9					
	1004	*h*	14.80	13.85	14.8					
No. 3293	1005	*e*	13.97	13.02	......	25.2				
1894, July 7	1010	*f*	14.69	13.74	......	26.6				
3^h54^m	1011	*h*	14.74	13.79	......	26.7				

TABLE I. *Diurnal Motions of the Flocculi*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3295 1894, July 9 2^h22^m	1013	*a*	14.26°	13.31°	......	24.9	38.1	53.3		
	1014	*a*	14.44	13.49	......	26.4	39.2	54.0	67.2	
	1015	*a*	14.14	13.19	......	24.9				
	1016	*a*	14.57	13.62	......	26.1	39.1			
	1017	*c*	14.30	13.35	......	25.2				
	1018	*c*	14.57	13.62	......	25.7				
	1019	*e*	14.62	13.67	......	25.8				
	1020	*e*	14.30	13.35	......	25.2				
	1022	*m*	12.82	11.87	......	22.4				
	1023	*m*	13.35	12.40	......	23.4				
No. 3300 1894, July 11 11^h40^m	1025	*h*	14.41	13.46	13.1					
	1026	*d*	15.00	14.05	13.9	30.1	43.4			
	1027	*h*	14.52	13.57	13.2					
	1028	*f*	14.21	13.26	12.9					
	1029	*f*	14.21	13.26	12.9					
	1030	*a*	15.03	14.08	13.7					
	1031	*c*	14.72	13.77	13.4					
	1032	*c*	15.24	14.29	13.9					
	1033	*c*	14.42	13.47	12.8	28.6	41.6			
	1034	*a*	14.95	14.00	13.8	29.6				
	1035	*a*	15.28	14.33	12.9	30.3				
	1036	*a*	14.82	13.87	13.0	29.3				
	1037	*c*	15.03	14.08	13.7					
	1038	*c*	14.83	13.88	13.5					
	1039	*f*	14.62	13.67	13.3					
	1040	*f*	14.41	13.46	13.1					
	1041	*h*	14.52	13.57	13.2					
No. 3303 1894, July 12 11^h01^m	1042	*g*	14.85	13.90	16.1	29.4				
	1043	*g*	14.25	13.30	14.9	28.1				
	1044	*c*	14.90	13.95	15.6	29.5				
	1045	*a*	14.95	14.00	16.3	29.6				
	1046	*a+c*	14.65	13.70	15.6					
	1047	*a*	14.74	13.79	15.7					
	1048	*h*	14.48	13.53	17.2	28.6				
No. 3308 1894, July 13 2^h21^m	1049	*e*	14.69	13.74	13.6	......	40.4			
	1050	*c*	14.06	13.11	12.8					
	1051	*e*	13.55	12.60	12.3					
	1052	*d*	14.98	14.03	13.7					
	1053	*f*	14.57	13.62	13.3					
	1054	*f*	14.37	13.42	13.1					
	1055	*g*	14.26	13.31	13.0					
	1056	*g*	13.96	13.01	12.7					
	1057	*c*	14.57	13.62	13.3					
	1058	*d*	14.37	13.42	13.1					
	1059	*b*	15.39	14.44	14.1					
	1060	*a*	14.26	13.31	13.0					
	1061	*a*	14.98	14.03	13.7					
	1062	*a*	15.09	14.14	13.8					
No. 3310 1894, July 14 1^h46^m										

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3315	1063	*b*	15.25°	14.30°	15.7					
1894, July 16	1064	*f*	15.22	14.27	15.4	27.4				
12^h59^m	1065	*d*	14.16	13.21	14.5					
	1066	*f*	14.52	13.57	14.9					
	1067	*f*	14.90	13.95	15.2	26.3	42.7			
	1068	*a*	14.55	13.60	14.3	25.5	41.5			
No. 3319	1069	*d*	15.20	14.25	......	27.9				
1894, July 17	1070	*f*	13.50	12.55	10.3					
3^h20^m	1072	*f*	14.47	13.52	11.1					
	1073	*d*	14.96	14.01	11.5					
	1074	*d*	15.20	14.25	......	27.9				
	1075	*d*	14.41	13.46	......	27.8	......	54.0		
No. 3320	1071	*d*	13.71	12.76	14.5					
1894, July 18	1076	*a*	14.43	13.48	15.4	......	43.0			
11^h02^m	1077	*d*	14.76	13.81	15.7					
	1078	*h*	13.44	12.49	14.2					
	1079	*f*	13.97	13.02	14.8					
	1081	*g*	14.27	13.32	15.9	......	42.5			
	1082	*e*	14.08	13.13	15.2	......	41.9			
	1083	*e*	14.77	13.82	15.4	......	44.1			
	1084	*e*	14.21	13.26	14.9	......	42.3			
	1085	*c*	14.55	13.60	15.5					
	1089	*i*	14.06	13.11	14.9					
	1090	*m*	13.53	12.58	14.3					
	1091	*k*	15.29	14.34	16.3					
No. 3326	1092	*d*	14.09	13.14	......	27.0				
1894, July 19	1093	*b+d*	13.56	12.61	......	25.9				
2^h19^m	1094	*e*	13.99	13.04	......	27.6	......	52.1		
No. 3333	1101	*g*	14.60	13.65	......	26.5				
1894, July 21	1102	*g*	14.42	13.46	......	26.6	......	53.4		
3^h37^m	1103	*g*	14.04	13.09	......	25.4				
	1104	*c*	14.11	13.15	......	26.3	......	52.1		
	1107	*g*	14.33	13.37	......	26.1	......	53.1		
	1108	*g*	13.62	12.67	......	24.6				
	1113	*f*	14.63	13.67	......	26.3	......	55.4	69.0	81.9
No. 3338	1115	*e*	14.31	13.35	......	27.0				
1894, July 23	1116	*d*	14.82	13.86	......	28.0				
2^h12^m	1117	*j*	13.68	12.72	......	25.7				
	1118	*e*	14.08	13.12	......	26.5				
	1119	*i*	13.86	12.90	......	25.7	39.2			
	1120	*k*	13.82	12.86	......	26.0				
	1123	*g*	13.76	12.80	......	24.6	39.7	52.3		
No. 3348	1125	*e*	13.78	12.82	12.4	25.9				
1894, July 25	1126	*g*	13.68	12.72	12.1	25.7				
2^h41^m	1127	*i*	14.07	13.11	13.1	26.5				
	1128	*i*	13.97	13.01	13.6	26.3				
	1129	*d*	14.67	13.71	14.3	27.7				
	1130	*d*	14.50	13.54	13.7					
	1131	*c*	14.97	14.01	14.2					
	1132	*c*	14.57	13.61	13.8					

TABLE 1. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3348—*Cont'd.*	1133	*c*	13.87°	12.91°	13.1					
	1134	*g*	14.07	13.11	13.3					
	1135	*e*	13.19	12.23	12.4					
	1136	*a*	15.26	14.30	14.5	28.9				
No. 3354	1138	*g*	14.38	13.42	13.5					
1894, July 26	1139	*g*	14.57	13.61	13.7					
2^h58^m	1140	*g*	14.57	13.61	13.7					
	1141	*d*	15.07	14.11	14.2					
	1142	*f*	15.37	14.41	14.5					
	1143	*f*	14.86	13.90	14.0					
	1144	*i*	13.08	12.12	12.2					
	1145	*e*	13.87	12.91	13.0					
	1146	*g*	14.07	13.11	13.2					
	1147	*g*	14.07	13.11	13.2					
No. 3355										
1894, July 27										
3^h07^m										
No. 3366	1149	*e*	14.01	13.05	......	24.9				
1894, July 30	1150	*i*	14.06	13.10	......	25.0				
1^h48^m	1151	*e*	14.79	13.83	......	26.2	40.5			
	1152	*e*	14.40	13.44	......	25.5	39.7	52.8		
	1153	*e*	14.08	13.12	......	25.7	38.4			
No. 3374	1154	*c*	14.86	13.90	14.0	28.2				
1894, Aug. 1	1155	*g*	12.94	11.98	12.2					
11^h37^m	1161	*e*	14.64	13.68	14.1	27.7				
	1162	*e*	13.93	12.97	13.2					
	1163	*a*	15.11	14.15	14.4					
	1164	*a*	15.11	14.15	14.4					
	1165	*a*	14.52	13.56	14.2	27.4				
	1166	*a*	14.71	13.75	14.0					
	1167	*d*	14.52	13.56	13.8					
	1168	*f*	13.83	12.87	13.1					
	1170	*a*	14.22	13.26	13.5					
	1171	*a*	14.61	13.65	13.9					
	1172	*c*	14.76	13.80	14.2	27.9				
No. 3382	1173	*e*	14.46	13.50	13.6	28.5				
1894, Aug. 2	1174	*i*	13.72	12.76	12.8					
12^h03^m	1175	*i*	14.01	13.05	13.1					
	1176	*e*	15.01	14.05	14.1					
	1177	*e*	14.61	13.65	13.7					
	1178	*c*	14.51	13.55	13.6					
	1179	*g*	14.71	13.75	13.8					
	1180	*a*	14.81	13.85	13.9					
	1181	*c*	14.81	13.85	13.8	29.2				
	1182	*c*	14.41	13.45	13.5					
	1183	*a*	14.11	13.15	13.7	27.7				
	1184	*e*	14.19	13.23	12.7	27.9				
	1185	*a*	15.00	14.04	13.7	29.6				
	1186	*g*	14.21	13.25	13.3					
	1188	*g*	14.11	13.15	13.2					
	1189	*c*	14.11	13.15	13.2					

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3388	1191	*f*	15.01°	14.05°	15.5					
1894, Aug. 3	1192	*a*	16.01	15.05	16.6					
12^h08^m	1193	*a*	16.36	15.40	17.0					
No. 3394	1194	*h*	14.62	13.66	......	28.4	40.6			
1894, Aug. 4	1195	*f*	14.67	13.71	......	28.2	40.8			
2^h37^m	1196	*h*	14.47	13.51	......	27.3				
No. 3398	1197	*d*	14.60	13.64	13.0					
1894, Aug. 6	1198	*d*	14.50	13.54	12.9					
3^h07^m	1199	*c*	14.71	13.75	13.1					
	1200	*c*	15.44	14.48	13.8					
	1201	*c*	14.89	13.93	13.5	27.5				
	1202	*c*	14.50	13.54	12.9					
	1203	*c*	14.82	13.86	13.6	27.5	39.4			
	1204	*c*	15.12	14.16	13.8	28.4	40.2			
	1205	*c*	15.44	14.48	13.8					
	1207	*e*	15.44	14.48	13.8					
	1209	*c*	14.25	13.29	12.5	26.2	37.7			
	1210	*c*	14.76	13.80	12.7	27.4	39.2			
	1211	*e*	14.37	13.41	13.5	27.2	38.2			
	1212	*g*	13.48	12.52	12.2	24.8				
	1213	*c*	14.39	13.43	12.7	26.5				
	1214	*e*	14.64	13.68	13.0	27.0				
	1216	*a*	15.13	14.17	13.5					
	1217	*a*	15.13	14.17	13.5					
	1218	*a*	15.02	14.06	13.4					
	1219	*g*	13.84	12.88	12.8	25.2	36.6			
	1222	*c*	13.73	12.77	13.0	25.2				
	1223	*c*	14.92	13.96	13.3					
No. 3405	1206	*g*	14.64	13.68	13.3	25.8				
1894, Aug. 7	1215	*c*	14.73	13.77	13.7	26.0				
1^h59^m	1220	*c*	14.98	14.02	14.3					
	1221	*e*	14.20	13.24	13.5					
	1224	*c*	14.79	13.83	14.0	26.1				
	1225	*g*+*i*	13.71	12.75	13.0					
	1226	*e*	14.69	13.73	14.0					
	1227	*c*	15.28	14.32	14.3	27.0				
	1229	*a*	15.36	14.40	15.2	27.2				
No. 3411	1230	*e*	15.39	14.43	12.5					
1894, Aug. 8	1231	*c*	14.93	13.97	12.1					
2^h28^m	1232	*e*	15.05	14.09	12.2					
	1233	*e*	14.01	13.05	11.3					
	1234	*d*	15.16	14.20	12.3					
	1236	*d*	14.93	13.97	12.1					
	1237	*c*	14.93	13.97	12.1					
No. 3417										
1894, Aug. 9										
11^h15^m										
No. 3424	1239	*f*	14.16	13.20	......	28.1				
1894, Aug. 14	1240	*f*	13.83	12.87	......	27.4				
10^h56^m	1241	*d*	14.25	13.29	......	28.3				

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3424—*Cont'd.*	1242	*c*	14.96°	14.00°	......	29.8				
	1243	*a*	14.49	13.53	......	29.2	42.0			
	1249	*e*	14.28	13.32	......	28.4	41.4			
	1251	*d*	14.02	13.06	......	27.8				
	1252	*g*	13.73	12.77	......	27.2				
No. 3429	1253	*e*	14.12	13.16	13.3	24.4				
1894, Aug. 16	1254	*e*	14.05	13.09	13.4	24.3				
2^h02^m	1255	*c*	14.11	13.15	12.9					
	1256	*c*	13.89	12.93	12.7	24.0				
	1257	*e*	14.64	13.68	13.5	25.4				
	1258	*g*	14.42	13.46	13.2					
	1259	*i*	14.31	13.35	13.1					
	1260	*i*	14.72	13.76	13.5					
	1261	*h*	14.81	13.85	13.5	25.7				
	1263	*m*	13.60	12.64	12.4					
	1264	*f*	14.01	13.05	12.8					
	1265	*f*	13.99	13.03	12.0	24.2				
	1266	*f*	15.03	14.07	13.8					
	1267	*f*	13.70	12.74	12.5					
No. 3439	1268	*e*	15.02	14.06	12.3					
1894, Aug. 17	1269	*e*	14.45	13.49	11.8					
1^h35^m	1270	*d*	15.02	14.06	12.3					
	1271	*h*	14.67	13.71	12.0					
	1272	*d*	15.25	14.29	12.5					
	1273	*h*	15.13	14.17	12.4					
	1274	*c*	14.79	13.83	12.1					
	1275	*c*	14.67	13.71	12.0					
	1276	*a*	15.47	14.51	12.7					
	1277	*a*	14.67	13.71	12.0					
	1278	*a*	15.70	14.74	12.9					
	1280	*b*	15.02	14.06	12.3					
	1282	*e*	13.76	12.80	11.2					
	1283	*i*	14.56	13.60	11.9					
	1284	*o*	11.70	10.74	9.4					
	1285	*m*	12.73	11.77	10.3					
	1286	*k*	13.53	12.57	11.0					
	1287	*q*	13.53	12.57	11.0					
No. 3441										
1894, Aug. 18										
10^h35^m										
No. 3447	1288	*h*	14.48	13.52	13.6					
1894, Aug. 21	1289	*d*	14.36	13.40	13.5	26.9				
10^h52^m	1290	*b*	14.18	13.22	13.3					
	1291	*c*	14.88	13.92	14.0					
	1292	*e*	14.48	13.52	13.6					
	1293	*c*	13.98	13.02	13.1					
	1294	*f*	14.48	13.52	13.6					
	1296	*j*	14.78	13.82	13.9					
	1297	*j*	14.68	13.72	13.8					
	1298	*d*	14.38	13.42	13.5					
	1299	*e*	13.93	12.97	13.8	26.0				
	1300	*f*	13.98	13.02	13.1					
	1305	*i*	13.29	12.33	12.4					

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3453	1307	*i*	13.27°	12.31°	12.3					
1894, Aug. 22	1308	*b*	14.77	13.81	13.8					
11^h00^m	1309	*g*	14.28	13.32	13.6	28.2				
	1310	*i*	14.37	13.41	13.7	28.4				
	1311	*i*	14.27	13.31	13.3					
	1312	*g*	14.27	13.31	13.3					
	1313	*g*	14.57	13.61	13.6					
	1314	*i*	14.17	13.21	13.2					
	1316	*g*	14.37	13.41	13.4					
	1317	*g*	14.57	13.61	13.6					
	1318	*e+g*	14.75	13.79	14.0	29.2				
	1319	*g*	14.14	13.18	13.4	27.9				
No. 3456	1320	*i*	13.88	12.91	14.9	26.2				
1894, Aug. 23	1321	*d*	14.30	13.34	14.9					
10^h59^m	1322	*k*	13.94	12.98	14.5					
	1323	*m*	13.85	12.89	14.4					
	1324	*h*	14.12	13.15	14.3	26.6				
	1325	*g*	13.68	12.72	14.2					
No. 3462	1326	*d*	14.22	13.25	12.0					
1894, Aug. 24	1327	*f*	14.22	13.25	12.0					
1^h47^m	1328	*i*	13.34	12.37	11.2					
	1329	*m*	13.89	12.92	11.7					
	1330	*i*	13.01	12.04	10.9					
	1332	*k*	13.78	12.81	11.6					
	1333	*b*	14.33	13.36	12.1					
	1334	*b*	14.00	13.03	11.8					
No. 3464 1894, Aug. 25 11^h31^m										
No. 3467	1335	*a*	14.24	13.27	13.2					
1894, Aug. 31	1337	*b*	14.14	13.17	13.1					
2^h18^m	1338	*g*	13.94	12.97	12.9					
	1339	*k*	12.53	11.56	11.5					
	1340	*g*	14.04	13.07	13.0					
	1341	*c*	14.95	13.98	13.9					
	1342	*c*	14.24	13.27	13.2					
	1344	*e*	14.24	13.27	13.2					
	1345	*a*	14.14	13.17	13.1					
	1346	*i*	14.34	13.37	13.3					
	1347	*a*	14.85	13.88	13.8					
	1348	*g*	13.94	12.97	12.9					
	1349	*f*	14.24	13.27	13.2					
	1350	*h*	13.74	12.77	12.7					
No. 3473 1894, Sept. 1 2^h10^m										
No. 3476	1355	*d*	13.69	12.72	......	......	38.1			
1894, Sept. 5	1356	*m*	13.67	12.70	......	26.1	37.9			
2^h26^m	1357	*m*	13.99	13.02	......	26.6	38.9			

TABLE I. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3479 1894, Sept. 7 2^h52^m										
No. 3488 1894, Sept. 17 2^h32^m	1377	*d*	14.91°	13.93°	15.0	27.6				
	1378	*d*	14.91	13.93	15.1	27.6				
	1379	*d*	14.91	13.93	14.8					
	1380	*d*	15.85	14.87	15.8					
	1381	*f*	14.46	13.48	14.5	26.7				
	1382	*d*	15.31	14.33	15.6	28.4				
	1383	*b*	15.19	14.21	15.1					
	1384	*e*	15.10	14.12	15.0					
	1385	*i*	14.05	13.07	14.4	25.9				
	1386	*i*	14.15	13.17	14.3	26.1				
	1387	*i*	13.70	12.72	14.0	25.2				
	1388	*i*	14.56	13.58	......	26.9				
	1389	*i*	14.40	13.42	14.3	26.6				
	1390	*a*	14.55	13.57	14.3	27.0	......	......	67.6	
	1391	*b*	14.75	13.77	14.4	27.3				
	1392	*b*	14.34	13.36	14.2					
	1393	*a*	15.10	14.12	15.0					
	1394	*a*	14.72	13.74	14.6					
	1395	*d*	14.65	13.67	15.0	27.1				
	1396	*f*	14.65	13.67	14.6	27.1				
	1397	*f*	14.06	13.08	13.9					
	1398	*f*	15.10	14.12	15.0					
	1399	*l*	14.15	13.17	15.1	26.1				
	1400	*j*	13.69	12.71	13.5					
	1401	*g*	14.35	13.37	14.6	26.5				
	1402	*i*	15.00	14.02	14.9					
	1403	*b*	14.72	13.74	14.6					
	1404	*d*	14.76	13.78	14.7	27.3				
	1405	*a*	14.82	13.84	14.7					
	1406	*n*	13.35	12.37	13.0	24.5				
	1407	*b*	14.56	13.58	14.5	26.9				
	1408	*b*	14.58	13.60	14.9	27.2	......	......	67.7	
No. 3493 1894, Sept. 18 4^h03^m	1409	*k*	14.27	13.29	12.2					
	1410	*k*	13.51	12.53	11.5					
	1412	*f*	14.38	13.40	12.3					
	1413	*h*	13.83	12.85	11.8					
	1414	*l*	13.83	12.85	11.8					
No. 3498 1894, Sept. 19 2^h05^m										
No. 3503 1894, Sept. 22 1^h46^m	1417	*g*	13.70	12.72	......	23.0	37.6	51.4		
	1418	*g*	14.04	13.06	......	24.8	39.2			
	1419	*s*	11.88	10.90	......	20.5				
No. 3507 1894, Sept. 24 10^h53^m	1420	*g*	13.75	12.77	14.3					
	1421	*e*	13.40	12.42	13.9					
	1422	*a*	14.20	13.22	14.9	28.2				
	1423	*a*	14.34	13.36	14.9	28.5				
	1424	*a*	14.77	13.79	15.3	29.4				

TABLE 1. *Diurnal Motions of the Flocculi.*—Continued.

Plate No. and date.	No.	Zone	Diurnal motion, sidereal.	Diurnal motion, synodic.	1	2	3	4	5	6
No. 3507—*Cont'd.*	1425	*a*	14.38°	13.40°	14.7	28.6				
	1426	*g*	14.44	13.46	14.8	28.7				
	1427	*d*	14.74	13.76	15.4					
No. 3509 1894, Sept. 25 1^h45^m	1428	*e*	14.48	13.50	13.7					
	1429	*e*	14.18	13.20	13.4					
	1430	*g*	13.79	12.81	13.0					
	1431	*e*	14.58	13.60	13.8					
	1432	*d*	13.69	12.71	12.9					
	1433	*h*	14.18	13.20	13.4					
	1434	*h*	14.58	13.60	13.8					
	1436	*c*	14.58	13.60	13.8					
No. 3516 1894, Sept. 26 2^h06^m										
No. 3528 1894, Sept. 28 2^h34^m	1438	*e*	14.33	13.35	11.1					
	1439	*e*	14.57	13.59	11.3					
	1440	*c*	14.93	13.95	11.6					
	1441	*c*	14.45	13.47	11.2					
	1442	*h*	14.45	13.47	11.2					
	1443	*h*	14.09	13.11	10.9					
	1444	*f*	14.33	13.35	11.1					
	1445	*h*	13.85	12.87	10.7					
	1447	*h*	14.69	13.71	11.4					
	1448	*b*	15.05	14.07	11.7					
	1449	*a*	13.97	12.99	10.8					
	1450	*a*	14.45	13.47	11.2					
	1451	*e*	14.21	13.23	11.0					
	1452	*c*	14.21	13.23	11.0					
	1453	*a*	14.81	13.83	11.5					
	1454	*c*	15.18	14.20	11.8					
No. 3533 1894, Sept. 29 10^h31^m										

The diurnal motions (ξ) of all the flocculi lying within each zone five degrees wide are grouped in table 2. The mean diurnal motion for each zone, together with its probable error, and the equivalent rotation period in days, are also given. In deriving the mean, the diurnal motions are weighted according to the interval in days.

TABLE 2. *Diurnal Motions Corresponding to each Five-Degree Zone.*

No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.
[Zone $a = 0°$ to $5°$. Mean Diurnal Motion $= 14.72° \pm 0.031$.]											
98	1	14.67°	819′	1	14.64°	1030	1	15.03°	1193	1	16.36°
106	5	14.62	820	1	14.92	1034	2	14.95	1216	1	15.13
104	3	13.56	821	2	14.35	1035	2	15.28	1217	1	15.13
91	1	14.06	827	2	14.59	1036	2	14.82	1218	1	15.02
107	2	13.80	842	4	15.00	1045	2	14.95	1229	2	15.36
302	2	14.57	853	3	14.75	1046	1	14.65	1243	3	14.49
410	1	14.34	877	3	14.49	1047	1	14.74	1276	1	15.47
411	1	14.79	898	2	14.59	1060	1	14.26	1277	1	14.67
455	1	15.05	899	2	14.21	1061	1	14.98	1278	1	15.70
472	1	14.31	936	2	14.91	1062	1	15.09	1335	1	14.24
470	2	14.90	936′	1	14.54	1068	3	14.55	1345	1	14.14
477	2	14.48	953	1	14.41	1076	3	14.43	1347	1	14.85
491	3	14.46	970	1	14.15	1136	2	15.26	1390	5	14.55
507	1	14.20	972	1	13.82	1163	1	15.11	1393	1	15.10
553	1	14.99	977	2	14.39	1164	1	15.11	1394	1	14.72
554	1	15.48	978	1	15.20	1165	2	14.52	1405	1	14.82
588	1	13.84	985	2	15.09	1166	1	14.71	1422	2	14.20
608	2	14.70	987	1	15.07	1170	1	14.22	1423	2	14.34
671	1	13.80	988	1	14.55	1171	1	14.61	1424	2	14.77
674	1	14.70	1013	4	14.26	1180	1	14.81	1425	2	14.38
731	1	15.06	1014	5	14.44	1183	2	14.11	1449	1	13.97
743	1	14.95	1015	2	14.14	1185	2	15.00	1450	1	14.45
761	1	14.30	1016	3	14.57	1192	1	16.01	1453	1	14.81
785	4	14.34									
[Zone $b = 0°$ to $-5°$. Mean Diurnal Motion $= 14.57° \pm 0.045$.]											
32	1	13.99°	458	3	14.09°	882	1	14.78°	1063	1	15.25°
34′	2	14.72	489	3	14.52	897	2	14.92	1093	2	13.56
38	1	15.24	672	1	14.80	918	2	14.19	1280	1	15.02
36′	2	13.81	673	1	13.80	924	1	15.38	1308	1	14.77
36″	2	14.26	719	5	14.40	925	1	14.99	1290	1	14.18
38‴	1	14.57	733	1	14.62	934	4	14.56	1333	1	14.33
52	5	14.75	732	2	14.24	945	2	14.95	1334	1	14.00
53′	1	14.73	749	1	14.71	954	1	14.54	1337	1	14.14
55	5	14.68	751	1	14.60	955	1	14.14	1383	1	15.19
87	2	14.66	793	2	15.13	971	2	14.19	1391	2	14.75
217	1	15.12	828	1	14.73	973	2	14.86	1392	1	14.34
225	1	13.88	850	2	15.34	974	1	15.71	1403	1	14.72
230	2	12.37	879	1	15.20	975	3	14.65	1407	2	14.56
264	1	15.18	880	1	14.64	976	2	14.75	1408	5	14.58
315	1	15.84	881	1	14.50	1059	1	15.39	1448	1	15.05
361	1	14.30									
[Zone $c = 5°$ to $10°$. Mean Diurnal Motion $= 14.50° \pm 0.027$.]											
1	3	14.74°	183	1	13.55°	447	3	14.07°	572	1	14.34°
19	3	14.84	184	1	15.45	448	1	14.22	577	2	14.24
1′	3	14.62	381	1	15.84	450	1	14.42	578	2	14.24
37′	3	14.37	382	1	14.30	451	1	14.78	670	1	14.70
78	2	14.33	386	1	13.69	452	1	14.42	693	1	14.37
82	1	15.13	407	1	14.98	456	3	14.76	702	2	14.64
106′	1	14.40	415	1	14.60	552	2	15.01	703	2	14.40
132	5	13.70	422	1	14.79	571	1	13.97	704	2	14.49

TABLE 2. *Diurnal Motions Corresponding to each Five-Degree Zone.*—Continued.

[Zone $c = 5°$ to $10°$. Mean Diurnal Motion $= 14.50° \pm 0.027$.—*Continued.*]

No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.
721	1	12.91°	904	3	14.44°	1057	1	14.57°	1222	2	13.73°
722	1	13.51	912	3	14.47	1085	1	14.55	1223	1	14.92
726	2	14.49	921	2	14.57	1104	4	14.11	1215	2	14.73
740	2	14.50	922	2	14.29	1131	1	14.97	1220	1	14.98
758	1	13.25	920	2	13.90	1132	1	14.57	1224	2	14.79
760	1	14.15	928	3	14.25	1133	1	13.87	1227	2	15.28
762	1	14.98	947	1	14.27	1154	2	14.86	1231	1	14.93
768	1	14.30	948	1	13.46	1172	2	14.76	1237	1	14.93
776	1	14.10	949	1	14.95	1178	1	14.51	1242	2	14.96
779	1	14.59	963	1	12.79	1181	2	14.81	1255	1	14.11
784	4	14.53	982	2	14.70	1182	1	14.41	1256	2	13.89
822	1	14.64	984	2	14.34	1189	1	14.11	1274	1	14.79
823	1	14.82	996	2	14.38	1199	1	14.71	1275	1	14.67
825	1	14.36	1017	2	14.30	1200	1	15.44	1291	1	14.88
826	1	14.45	1018	2	14.57	1201	2	14.89	1293	1	13.98
822′	1	14.73	1031	1	14.72	1202	1	14.50	1341	1	14.95
843	4	14.70	1032	1	15.24	1203	3	14.82	1342	1	14.24
861	1	14.52	1033	3	14.42	1204	3	15.12	1436	1	14.58
862	1	15.14	1037	1	15.03	1205	1	15.44	1440	1	14.93
872	1	13.99	1038	1	14.83	1209	3	14.25	1441	1	14.45
873	3	14.17	1044	2	14.90	1210	3	14.76	1452	1	14.21
891	2	14.28	1046	1	14.65	1213	2	14.39	1454	1	15.18
903	2	14.76	1050	1	14.06						

[Zone $d = -5°$ to $-10°$. Mean Diurnal Motion $= 14.55° \pm 0.030$.]

No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.
27	3	14.42°	364	1	14.39°	750	1	15.39°	1093	2	13.56°
36	2	14.62	365	1	13.69	773	1	14.49	1116	2	14.82
35	3	15.87	387	1	13.52	792	2	14.57	1129	2	14.67
51	5	14.69	394	1	13.69	795	2	14.27	1130	1	14.50
51′	3	14.93	417	1	14.44	805	1	14.21	1141	1	15.07
57′	1	14.78	418	1	15.08	829	1	15.11	1167	1	14.52
50	2	15.08	457	1	13.54	841	3	14.82	1197	1	14.60
75	2	14.03	459	3	14.03	866	1	15.05	1198	1	14.50
109	2	14.52	461	1	14.31	876	3	14.15	1234	1	15.16
138	6	14.58	468	1	13.81	878	1	13.80	1236	1	14.93
168	4	14.64	469	1	13.54	883	1	15.20	1241	2	14.25
168′	4	14.75	487	2	14.52	894	2	14.43	1251	2	14.02
165′	3	14.52	488	3	14.52	896	2	14.54	1270	1	15.02
165	1	14.06	514	2	14.50	943	2	15.00	1272	1	15.25
228	1	14.46	522	2	15.10	964	1	15.48	1289	2	14.36
232	3	14.72	520	1	14.24	969	1	14.23	1298	1	14.38
242	3	14.48	530	2	14.87	990	2	14.64	1321	1	14.30
258	1	14.87	531	2	14.60	1026	3	15.00	1326	1	14.22
259	1	14.42	615	1	14.56	1052	1	14.98	1355	3	13.69
261	1	15.03	631	1	14.06	1058	1	14.37	1377	2	14.91
304	3	13.62	634	1	13.98	1065	1	14.16	1378	2	14.91
314	1	14.41	635	1	13.89	1069	2	15.20	1379	1	14.91
316	1	14.12	644	1	13.69	1073	1	14.96	1380	1	15.85
347	3	14.06	677	1	15.00	1074	2	15.20	1382	2	15.31
356	3	15.19	733	1	14.62	1075	4	14.41	1395	2	14.65
357	4	14.13	748	3	14.98	1071	1	13.71	1404	2	14.76
358	4	14.16	744	2	14.87	1077	1	14.76	1427	1	14.74
362	1	14.30	745	2	14.20	1092	2	14.09	1432	1	13.69
363	1	14.20	746	2	15.12						

TABLE 2. *Diurnal Motions Corresponding to each Five-Degree Zone.*—Continued.

[Zone $e = 10°$ to $15°$. Mean Diurnal Motion $= 14.34° \pm 0.024$.]

No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.
5'	3	14.42°	559	1	15.29°	902	1	14.25°	1176	1	15.01°
5	2	14.02	567	2	13.56	915	1	13.99	1177	1	14.61
4'	1	14.38	581	2	14.24	916	1	14.75	1184	2	14.19
2'	4	14.42	641	1	13.57	919	1	14.75	1207	1	15.44
33	2	14.78	675	1	13.70	895	1	14.58	1211	3	14.37
23'	1	14.15	694	1	14.03	929	1	13.70	1214	2	14.64
42	1	14.73	695	1	14.60	935	4	14.40	1221	1	14.20
42'	2	14.19	699	2	14.54	937	2	14.31	1226	1	14.69
44	3	13.69	724	1	13.92	950	1	13.87	1230	1	15.39
44'	2	14.41	725	4	14.02	1005	2	13.97	1232	1	15.05
56'	1	13.93	737	3	14.20	1019	2	14.62	1233	1	14.01
71	1	14.58	738	1	13.51	1020	2	14.30	1249	3	14.28
78'	2	14.71	739	1	14.23	1049	3	14.69	1253	2	14.12
84	3	15.27	727	1	14.42	1051	1	13.55	1254	2	14.05
129	3	14.10	764	1	14.98	1082	3	14.08	1257	2	14.64
185	1	13.99	765	1	14.20	1083	3	14.77	1268	1	15.02
223	2	14.63	767	1	14.20	1084	3	14.21	1269	1	14.45
233	1	14.82	780	1	14.49	1094	4	13.99	1282	1	13.76
252	2	14.61	781	2	14.41	1115	2	14.31	1292	1	14.48
253	4	14.15	782	2	14.20	1118	2	14.08	1299	2	13.93
268	3	14.79	783	2	14.30	1125	2	13.78	1318	2	14.75
289	4	14.12	786	2	14.52	1135	1	13.19	1344	1	14.24
344	3	14.06	790	2	13.87	1145	1	13.87	1384	1	15.10
405	1	14.89	798	1	14.21	1149	2	14.01	1421	1	13.40
406	1	14.98	807	1	14.51	1151	3	14.79	1428	1	14.48
412	1	15.28	824	1	14.45	1152	4	14.40	1429	1	14.18
414	1	14.70	869	1	14.26	1153	3	14.08	1431	1	14.58
429	1	14.51	871	1	14.61	1161	2	14.64	1438	1	14.33
428	1	15.38	874	5	14.30	1162	1	13.93	1439	1	14.57
499	1	13.54	901	1	14.25	1173	2	14.46	1451	1	14.21
548	1	15.27									

[Zone $f = -10°$ to $-15°$. Mean Diurnal Motion $= 14.39 \pm 0.020$.]

No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.
18	2	14.26°	248	6	14.96°	373	1	15.17°	535	1	14.70°
26'	1	14.41	249	1	12.98	374	1	14.67	560	4	14.60
54	4	14.57	251	4	14.33	420	1	14.60	568	4	14.41
60	3	14.01	260	1	15.32	467	1	14.13	555	4	14.01
61	4	14.14	263	1	15.32	468	1	13.81	574	3	14.09
64'	1	13.97	265	1	14.06	474	1	14.13	585	1	15.70
79	2	13.74	297	3	14.69	483	5	13.97	586	3	14.01
92	2	14.67	298	3	14.88	484	5	13.87	587	3	14.08
99	1	14.67	304	3	13.62	485	5	13.84	589	1	15.39
93'	1	13.65	305	3	14.42	486	3	14.27	592	3	14.45
103	3	13.97	311	1	13.84	500	3	14.43	596	1	14.80
116	2	14.11	326	1	13.74	501	3	14.63	632	1	14.19
124	5	14.14	330	1	15.26	505	1	15.34	633	1	14.09
133	4	14.31	353	4	14.26	512	2	14.50	636	1	14.09
141	3	14.40	354	3	14.61	515	2	14.39	639	1	14.19
142	1	14.63	355	3	14.52	516	2	13.80	640	1	14.40
163	5	14.55	360	3	14.44	519	1	14.09	650	1	13.79
145	1	12.78	367	1	14.39	523	1	12.99	654	1	14.70
164'	3	15.01	368	1	13.15	524	1	13.98	669	1	14.80
191	1	14.36	372	1	14.77	533	2	14.05	678	1	14.80

TABLE 2. *Diurnal Motions Corresponding to each Five-Degree Zone.*—Continued.

[Zone f = —10° to 15°. Mean Diurnal Motion = 14.39° ± 0.020.—*Continued.*]

No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.
682	3	14.22°	832	2	14.87°	967	1	14.56°	1079	1	13.97°
690	1	15.06	833	5	14.36	968	2	14.39	1113	6	14.63
705	2	14.49	839	2	14.43	981	1	13.99	1142	1	15.37
709	2	14.49	840	2	14.65	986	3	14.65	1143	1	14.86
710	2	14.49	840′	1	15.01	991	4	14.35	1168	1	13.83
711	2	14.30	844	2	14.86	992	2	14.38	1191	1	15.01
712	2	14.69	845	1	14.32	993	2	14.34	1195	3	14.67
713	2	14.64	846	1	14.73	994	2	14.20	1239	2	14.16
714	2	14.35	848	1	14.42	995	2	14.14	1240	2	13.83
741	1	14.02	851	3	14.48	1001	1	14.89	1264	1	14.01
747	2	15.17	852	3	14.51	1003	1	13.96	1265	2	13.99
754	1	15.39	860	1	14.87	1010	2	14.69	1266	1	15.03
769	1	14.49	868	1	14.87	1028	1	14.21	1267	1	13.70
771	1	14.69	875	4	13.87	1029	1	14.21	1294	1	14.48
774	2	14.48	884	1	14.92	1039	1	14.62	1300	1	13.98
775	2	13.96	885	1	14.08	1040	1	14.41	1327	1	14.22
813	1	14.92	886	1	15.06	1053	1	14.57	1349	1	14.24
815	1	13.61	892	1	13.80	1054	1	14.37	1381	2	14.46
816	1	14.54	893	2	14.43	1064	2	15.22	1396	2	14.65
817	1	14.36	917	1	14.88	1066	1	14.52	1397	1	14.06
818	1	15.01	944	2	15.10	1067	3	14.90	1398	1	15.10
819	2	14.45	946	1	14.14	1070	1	13.50	1412	1	14.38
830	2	14.35	966	2	14.75	1072	1	14.47	1444	1	14.33

[Zone g = 15° to 20°. Mean Diurnal Motion = 14.18° ± 0.028.]

No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.
23	4	14.06°	320	1	15.21°	797	1	14.31°	1140	1	14.57°
46	4	14.15	338	1	14.34	808	1	13.60	1146	1	14.07
58′	1	15.47	339	4	14.28	809	1	13.19	1147	1	14.07
70	1	14.58	380	1	13.15	810	1	14.11	1155	1	12.94
77	1	14.58	492	2	14.59	863	3	14.56	1179	1	14.71
68	3	14.26	493	1	14.68	900	1	14.01	1186	1	14.21
83	5	13.97	494	1	14.68	905	1	14.75	1188	1	14.11
77′	2	14.37	497	1	14.46	906	1	15.26	1212	2	13.48
89	2	13.81	506	1	13.72	913	1	13.74	1219	3	13.84
90	4	13.88	509	2	13.56	938	3	14.46	1206	2	14.64
101	3	13.81	510	2	13.65	939	3	14.50	1225	1	13.71
108′	5	13.55	565	1	14.27	940	4	14.08	1252	2	13.73
108	2	13.42	566	1	13.95	951	1	14.95	1258	1	14.42
118′	4	13.57	570	3	13.93	952	1	14.95	1309	2	14.28
111	2	14.40	613	1	13.96	979	1	13.32	1312	1	14.27
112	2	13.89	614	1	14.27	1042	2	14.85	1313	1	14.57
108″	2	15.27	642	1	14.09	1043	2	14.25	1316	1	14.37
143	1	14.21	700	2	14.35	1055	1	14.26	1317	1	14.57
134	1	14.29	723	1	14.22	1056	1	13.96	1318	2	14.75
208	1	14.40	728	1	13.92	1081	3	14.27	1319	2	14.14
236	2	14.72	729	1	13.31	1101	2	14.60	1325	1	13.68
240	2	14.87	730	3	13.89	1102	4	14.42	1338	1	13.94
241	2	14.77	736	1	14.32	1103	2	14.04	1340	1	14.04
254	2	13.73	759	1	14.60	1107	4	14.33	1348	1	13.94
244′	2	13.68	766	1	14.78	1108	2	13.62	1401	2	14.35
273	4	14.01	778	1	14.40	1123	4	13.76	1417	4	13.70
281	5	13.72	787	2	14.30	1126	2	13.68	1418	3	14.04
301	4	14.38	788	2	14.41	1134	1	14.07	1420	1	13.75
306	3	14.13	789	2	13.65	1138	1	14.38	1426	2	14.44
319	1	14.67	794	1	13.93	1139	1	14.57	1430	1	13.79

TABLE 2. *Diurnal Motions Corresponding to each Five-Degree Zone.*—Continued.

[Zone $h = -15°$ to $-20°$. Mean Diurnal Motion $= 14.32° \pm 0.031$.]

No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.
14	1	13.78°	256	4	13.84°	563	4	13.55°	849	3	14.57°
15	2	13.89	257	1	14.94	573	1	14.88	855	3	14.27
26	1	12.54	262	1	15.79	583	1	13.31	864	1	15.23
47′	4	14.22	266	1	15.71	584	1	14.51	867	1	15.14
49	3	14.64	271	1	13.86	590	1	14.33	870	4	14.37
47″	2	13.29	276	5	14.08	594	1	13.93	890	4	14.40
62	4	14.66	280	5	14.08	607	2	14.50	887	2	14.65
62′	1	13.65	283	3	14.42	603	1	14.61	965	1	13.73
79′	2	14.11	284	3	13.63	611	1	14.10	1002	1	14.52
80	2	14.17	290	2	14.58	637	1	13.79	1004	1	14.80
49′	2	14.74	291	2	14.57	655	1	14.30	1011	2	14.74
80″	1	13.56	292	2	14.58	658	1	14.50	1025	1	14.41
113	2	13.89	310	1	14.02	668	1	14.80	1027	1	14.52
114	2	14.10	329	4	14.09	679	3	14.71	1041	1	14.52
136	2	14.37	331	4	14.04	680	2	14.52	1048	2	14.48
150	2	13.84	333	1	14.92	681	3	13.93	1078	1	13.44
150′	2	14.54	345	3	13.66	683	3	14.13	1194	3	14.62
156	2	15.84	346	3	14.06	684	2	15.14	1196	2	14.47
155	2	14.25	391	1	13.42	689	1	15.29	1261	2	14.81
150″	1	13.23	393	1	13.24	715	2	14.30	1271	1	14.67
174	1	15.11	473	1	14.67	716	2	14.35	1273	1	15.13
175	1	13.86	481	3	14.56	718	2	14.68	1288	1	14.48
176	1	14.15	482	3	14.54	734	1	14.13	1324	2	14.12
211	1	14.40	490	3	14.57	752	1	13.81	1350	1	13.74
212	1	14.50	513	2	13.85	753	1	14.38	1413	1	13.83
219	2	14.21	528	1	14.09	755	1	14.60	1433	1	14.18
226	6	14.25	529	1	13.67	831	2	14.35	1434	1	14.58
235	2	14.36	525	2	14.14	834	1	14.36	1442	1	14.45
238	5	14.19	534	2	14.39	835	1	14.64	1443	1	14.09
239	1	14.74	556	3	14.34	837	4	14.57	1445	1	13.85
245	2	14.78	561	2	13.86	838	5	14.39	1447	1	14.69
247	2	14.49	562	1	14.62						

[Zone $i = 20°$ to $25°$. Mean Diurnal Motion $= 14.16° \pm 0.038$.]

No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.
3	3	14.59°	224	2	14.23°	696	1	14.14°	1174	1	13.72°
6	2	14.29	231	1	15.65	697	1	14.26	1175	1	14.01
4	2	14.71	275	4	13.66	756	1	14.72	1225	1	13.71
29	2	14.49	336	1	14.07	757	1	14.60	1259	1	14.31
30	2	14.06	337	1	13.56	763	1	14.59	1260	1	14.72
30′	1	14.66	340	1	12.94	777	2	13.38	1283	1	14.56
29′	1	14.66	375	1	13.81	791	2	14.03	1305	1	13.29
83′	1	13.65	376	1	14.59	803	1	14.21	1307	1	13.27
90′	3	13.80	377	1	14.59	806	1	14.11	1310	2	14.37
90″	1	13.87	383	1	14.67	900	1	14.01	1311	1	14.27
118	6	13.62	384	1	13.81	908	1	13.61	1314	1	14.17
110	4	14.18	389	1	13.90	926	1	14.31	1320	2	13.88
89′	2	14.57	495	3	14.10	941	2	14.60	1328	1	13.34
121′	2	14.25	498	1	13.89	942	2	14.95	1330	1	13.01
135	3	13.91	541	3	13.71	980	2	13.84	1346	1	14.34
137	1	14.57	540	2	13.91	1089	1	14.06	1385	2	14.05
139	2	14.24	582	2	15.79	1119	3	13.86	1386	2	14.15
140	3	13.31	549	3	14.35	1127	2	14.07	1387	2	13.70
140′	1	14.76	612	1	14.56	1128	2	13.97	1388	2	14.56
206	3	13.93	621	1	14.77	1144	1	13.08	1402	1	15.00
214	3	14.44	676	1	15.10	1150	2	14.06	1389	2	14.40
215	3	14.25									

TABLE 2. *Diurnal Motions Corresponding to each Five-Degree Zone.*—Continued.

No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.	No.	Days.	Diurnal motion, sidereal.
[Zone *j* = —20° to —25°.			Mean Diurnal Motion = 14.12° ± 0.042.]								
11	1	12.67°	102′	2	14.69°	462	3	14.43°	665	1	13.90°
22	3	12.07	160′	1	13.94	463	1	14.22	666	1	13.90
47	3	13.71	160	3	13.24	502	1	14.35	667	1	14.40
45	3	14.10	180	1	13.86	503	1	14.55	691	1	14.71
59	3	13.63	187	1	14.48	536	1	14.39	692	1	14.37
59′	2	14.00	188	1	13.55	543	2	14.39	706	2	14.35
63′	2	13.93	189	1	14.06	591	3	14.56	717	2	14.40
65	3	14.07	190	1	13.73	597	2	14.15	836	4	14.45
69	3	13.40	237	5	14.18	598	2	14.50	847	1	14.64
74	3	14.66	239	1	14.74	604	1	13.13	856	3	14.17
66′	2	14.43	246	4	14.43	605	1	12.36	858	1	14.34
80′	1	14.03	267	3	14.69	606	1	14.40	859	1	14.70
69′	1	14.18	269	1	13.86	648	1	14.51	865	1	14.17
94	4	14.12	270	3	14.32	656	1	14.40	888	1	14.50
95	4	14.08	278	2	14.19	657	1	14.90	889	1	14.22
97	6	13.91	279	2	14.52	661	1	14.00	1117	2	13.68
96′	4	14.42	274	2	14.67	662	1	14.30	1296	1	14.78
97′	1	13.97	332	1	14.64	663	1	13.90	1297	1	14.68
102	4	14.00	392	1	12.53	664	1	14.30	1400	1	13.69
115	2	14.04									
[Zone *k* = 25° to 30°.			Mean Diurnal Motion = 13.74° ± 0.062.]								
3′	3	13.64°	221	2	13.09°	542	2	13.81°	927	1	14.22°
6′	2	14.07	222	2	12.80	575	1	13.24	1091	1	15.29
181	1	13.55	334	1	14.07	685	2	14.35	1120	2	13.82
195	1	13.33	335	1	13.14	687	2	14.43	1286	1	13.53
196	1	13.46	517′	1	12.75	698	1	14.03	1322	1	13.94
199	1	13.36	532	3	14.27	803	1	14.21	1332	1	13.78
200	3	13.07	539	3	14.10	804	1	14.00	1409	1	14.27
213	1	13.49	550	1	13.73	909	3	13.69	1410	1	13.51
220	2	13.37									
[Zone *l* = —25° to —30°.			Mean Diurnal Motion = 13.95° ± 0.082.]								
8	2	12.61°	171	4	14.05°	471	1	14.09°	651	1	13.79°
8′	1	12.61	171′	1	15.30	508	1	14.02	652	1	13.57
16	2	13.54	194	1	14.48	504	1	15.34	659	1	13.80
16′	2	13.19	186	1	13.60	537	2	14.30	660	1	14.30
38′	1	13.09	250	2	13.96	538	1	14.10	707	2	14.88
38″	5	14.35	255	2	14.29	544	2	13.98	770	2	13.60
45″	1	14.62	293	2	14.98	545	2	14.79	857	1	14.52
67′	4	14.39	294	2	14.73	546	2	13.29	1399	2	14.15
96	4	14.33	388	1	11.53	616	1	13.56	1414	1	13.83
152	1	13.10	465	1	13.81	617	1	13.56			
[Zone *m* = 30° to 35°.			Mean Diurnal Motion = 13.60° ± 0.069.]								
197	1	13.55°	686	2	13.88°	1023	2	13.35°	1323	1	13.85°
209	1	13.82	800	1	13.60	1090	1	13.53	1329	1	13.89
288	2	14.57	802	1	13.60	1263	1	13.60	1356	3	13.67
517	2	13.40	1022	2	12.82	1285	1	12.73	1357	3	13.99
569	1	13.43									
[Zone *n* = 30° to —35°.			Mean Diurnal Motion = 13.79° ± 0.124.]								
64	3	14.26°	153	4	14.10°	464	1	13.81°	626	1	12.84°
64″	1	13.91	157	2	14.96	466	1	12.76	653	1	13.98
151	2	13.96	170	1	13.23	610	1	14.29	1406	2	13.35

DISTRIBUTION AND AREAS OF THE FLOCCULI.

No very minute flocculi were measured in this investigation. The best-defined points, which showed the least change from day to day, were selected for measurement. In many cases these points were chosen in the outlying portions of large groups of flocculi; in others they represented the centers of smaller compact masses. In all cases, however, the measures relate to the coarser flocculi. They therefore afford no evidence as to the motions of those minute flocculi, not exceeding a second of arc in diameter, which are shown on the best plates obtained with the Rumford spectroheliograph or the 5-foot spectroheliograph of the Mount Wilson Solar Observatory.

The approximate distribution and area of the principal flocculi on the Sun during the period of this investigation were determined as follows: The globe, as already stated, is ruled with meridians and parallels 1° apart, the 10° lines being strengthened. In the squares thus formed, 10° on a side, the areas of the flocculi were estimated by counting the number of 1° squares covered by them. A sample record for the first plate is given below.

TABLE 3.

Latitude.		Longitude.							
		East of central meridian.			Central meridian.	West of central meridian.			
		−30 to −20	−20 to −10	−10 to 0		0 to 10	10 to 20	20 to 30	Total in zone.
40° to	30°	3	7	9		3	3	0	25
30	20	4	11	17		4	8	2	46
20	10	2	4	8		1	3	1	19
10	0	4	4	1		4	1	2	16
0° to	−10°	6	2	5		3	1	1	18
−10	−20	7	3	4		1	14	5	34
−20	−30	4	4	14		17	10	10	59
−30	−40	0	1	5		1	2	6	15
		East.				West.			

Only a limited area of the globe was used, but the results obtained from the considerable number of plates employed should be fairly representative. The last column of the above table gives the total area of the flocculi in each 10° zone. In table 4 these results are brought together, and the grand total for each zone is given. These totals have supplied the data for platting the curve shown in fig. 4. The curve at the opposite limb of the Sun on this plate shows the number of the flocculi in the various zones measured in determining the rotation periods. The scale of the ordinates of this curve is 1 inch to 250 points measured.

It should be remembered that in view of the varying density and contrast of the plates, and the great range of brightness of the flocculi, such estimates

of areas are necessarily very rough. They may serve, however, to give an idea of the distribution of the flocculi measured, and the approximate area occupied by them.

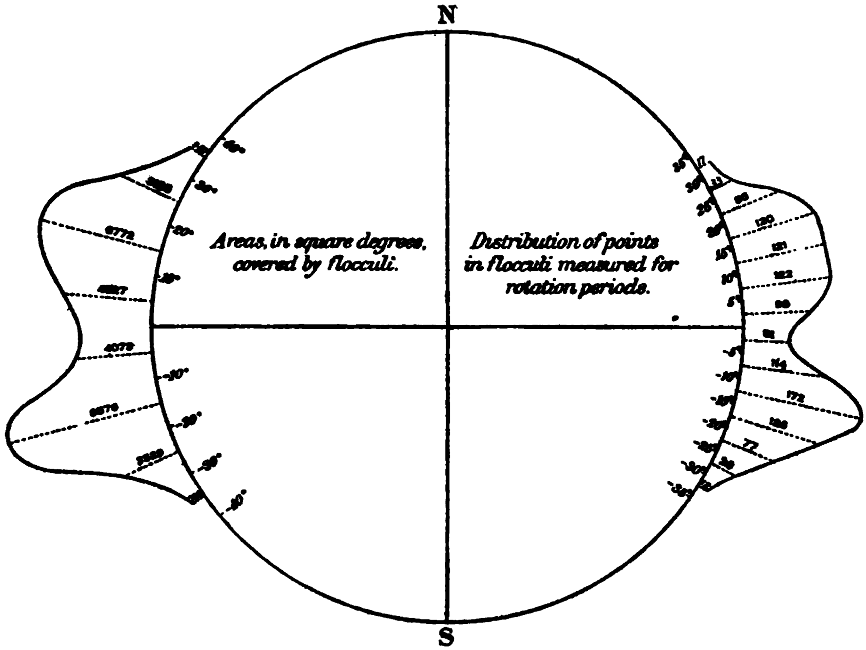

FIG. 4. DISTRIBUTION AND AREAS OF THE FLOCCULI.

TABLE 4. *Areas of the Flocculi.*

Plate No.	+40 to +30	+30 to +20	+20 to +10	+10 to 0	0 to −10	−10 to −20	−20 to −30	−30 to −40
2401	25	46	19	16	18	34	59	15
*2407	....	....	....	....	....	....	....	....
2421	20	33	44	18	21	108	40	8
2429	16	51	66	29	76	163	83	9
2442	7	31	67	25	77	221	57	8
2452	5	15	84	21	80	238	140	14
2465	2	19	125	22	64	214	108	15
2471	9	20	138	13	62	232	77	15
2482	7	15	112	12	58	186	79	14
2496	5	18	111	30	18	110	60	7
2501	1	22	94	55	31	43	38	7
2521	5	37	109	44	40	114	29	8
2542	1	29	37	13	8	78	23	1
2558	0	24	41	22	12	20	3	0
2560	1	25	33	22	8	27	14	2
2569	0	11	39	28	13	66	16	17
2580	3	9	5	6	24	108	63	22
2588	3	9	11	17	31	185	104	39
2590	5	33	35	37	29	173	141	36
2598	6	64	17	9	5	29	32	12
2617	11	82	16	4	5	30	13	1
2619	4	39	22	7	18	68	15	5
2628	1	15	68	9	47	123	40	4
2634	0	4	86	8	41	172	90	6
2639	1	6	106	13	42	138	82	3
2651	3	15	72	17	52	154	56	14
2675	8	14	40	30	22	58	26	13
2681	7	27	63	21	102	101	32	14
2694	5	34	53	26	73	51	24	2
2699	2	8	21	16	68	171	33	3
2712	9	28	33	24	61	80	11	6
*2722	....	....	....	....	....	....	....	....
2741	5	7	48	43	18	7	12	7
2756	6	17	25	7	16	11	16	1
2777	2	4	12	42	22	32	29	9
2787	0	10	18	38	20	34	44	14
2791	2	5	15	29	38	52	38	7
2797	6	13	33	18	30	51	18	7
2800	2	10	21	14	25	71	21	7
2809	6	15	16	7	27	112	6	0
2812	3	13	11	7	13	111	11	6
2818	9	66	25	27	13	35	34	5
2821	7	78	90	38	16	33	21	6
2829	5	61	132	17	5	68	12	8
2831	4	25	105	25	6	63	16	8
2839	2	9	67	6	7	58	11	10
2870	4	9	3	11	14	48	13	6
2877	1	5	4	14	13	46	17	6
2880	1	4	4	13	11	46	18	6
*2888	....	....	....	....	....	....	....	....
2898	1	30	72	6	21	23	12	14
2904	2	18	60	45	29	22	16	9
3020	0	5	17	14	24	54	25	14
3028	1	2	60	13	27	59	23	24
3062	2	12	22	27	14	63	44	3
3069	6	29	26	12	15	44	32	3
3079	4	20	19	12	10	46	22	5
3082	1	11	11	10	9	33	24	7
3093	2	23	27	55	31	51	44	2
3101	1	7	47	31	69	74	40	6
3104	6	6	73	23	26	15	11	3
3106	3	12	103	18	38	19	6	0
3112	1	14	32	21	46	22	10	1
3117	0	4	50	21	55	24	7	2
3121	0	2	31	15	30	22	16	6
3185	8	20	101	40	36	32	32	7
3190	0	22	138	30	56	15	7	1
3191	10	29	85	30	45	23	18	2
3196	3	14	62	15	40	15	7	0
3201	10	17	42	11	29	11	6	1

Plate No.	+40 to +30	+30 to +20	+20 to +10	+10 to 0	0 to −10	−10 to −20	−20 to −30	−30 to −40
3204	8	19	42	6	41	13	1	1
3207	8	15	28	90	30	181	60	7
3211	7	20	27	68	31	216	81	5
3214	2	11	20	57	27	159	58	1
3216	0	6	25	108	51	47	27	5
3218	6	10	43	85	19	50	34	3
3221	4	8	36	30	28	113	22	2
3223	1	11	31	26	29	124	27	1
3228	6	21	32	23	36	123	12	1
3232	2	12	25	17	43	130	13	1
3239	11	23	20	27	16	25	7	0
3241	8	29	50	32	19	18	14	2
3245	16	16	53	23	22	5	7	0
3247	6	13	92	40	20	13	4	0
3253	9	22	57	44	31	37	7	1
3258	6	20	59	35	24	46	4	5
3265	3	9	16	28	23	29	10	1
3272	12	20	29	44	41	36	2	0
3279	9	21	46	60	22	19	2	0
3284	5	18	42	77	24	35	4	0
3286	0	11	63	47	30	100	16	2
3293	7	16	66	64	49	110	58	1
3295	9	19	55	35	16	53	24	0
3300	12	14	39	112	19	47	32	1
3303	4	7	30	117	21	48	11	3
3308	5	17	66	119	30	32	8	2
3310	4	12	58	85	38	61	12	0
3315	6	15	36	49	57	136	16	2
3319	1	0	15	40	64	144	9	0
3320	16	31	43	59	34	136	9	2
3326	23	25	34	47	51	86	12	6
3333	22	31	126	19	13	12	6	1
3338	13	22	110	22	35	22	5	0
3348	39	57	88	35	46	23	12	1
3354	16	43	64	40	35	20	33	3
3355	16	44	67	26	34	17	44	5
3366	10	24	41	28	20	14	38	2
3374	7	27	35	27	11	14	2	0
3382	12	22	82	57	31	36	15	5
3388	5	23	129	113	23	33	23	1
3394	0	6	89	88	27	43	34	4
3398	3	9	95	92	24	77	35	9
3405	13	17	69	73	15	27	12	0
3411	5	16	75	61	14	47	8	5
3417	9	20	68	60	37	83	13	4
3424	9	20	28	35	21	52	14	2
3429	18	14	25	114	18	43	28	6
3439	30	33	49	127	24	22	4	2
3441	24	29	56	116	38	24	25	2
3447	11	23	21	18	27	36	18	2
3453	18	32	40	25	30	25	8	1
3456	16	38	42	12	11	17	9	3
3462	17	32	32	17	24	22	12	4
3464	13	21	25	13	23	26	6	2
3467	19	22	99	90	37	18	21	2
3473	11	25	104	67	13	20	20	5
3476	13	28	41	21	13	69	10	4
3479	14	18	21	18	11	28	8	3
3481	12	23	19	12	16	63	14	5
3488	15	27	23	36	66	27	12	8
3493	14	28	17	33	64	41	23	10
3498	13	32	22	43	55	36	15	14
3503	9	15	27	17	16	16	9	6
3507	10	19	49	24	10	17	8	4
3509	8	18	49	32	14	22	10	3
3516	2	15	37	45	14	26	20	3
3528	3	9	25	24	13	27	16	4
3533	4	16	31	34	14	19	9	5
Total	987	3519	6772	4827	4073	8576	3529	738

* Not measured.

DISCUSSION OF THE RESULTS.

The mean values of the diurnal motion for each zone of 5°, with the computed probable errors and the weights, are brought together in the following table. The weighted means for corresponding zones in north and south latitudes, together with their probable errors, are also included.

TABLE 5.

ϕ	North. ξ	Weight.	South. ξ	Weight.	Weighted mean. ξ
0° to 5°	14.72° ±0.031	156	14.57° ±0.045	103	14.66° ±0.026
5 10	14.50 .027	196	14.55 .030	202	14.52 .020
10 15	14.34 .024	208	14.39 .020	323	14.37 .016
15 20	14.14 .025	222	14.30 .028	240	14.22 .019
20 25	14.13 .035	143	14.11 .038	144	14.12 .026
25 30	13.74 .060	51	14.03 .073	66	13.90 .049
30 35	13.64 .073	26	13.93 .120	20	13.76 .067

A comparison of these results with those of Carrington, Spoerer, and Maunder for spots, Stratonoff for the faculæ, and Dunér and Halm for the reversing layer (iron lines), is given in fig. 5. Numerical comparisons are also given in the following pages. Before proceeding to these comparisons, it should be remarked that the large proper motions of the calcium flocculi must always stand in the way of very accurate results, unless a much greater number of observations than those here included are available.

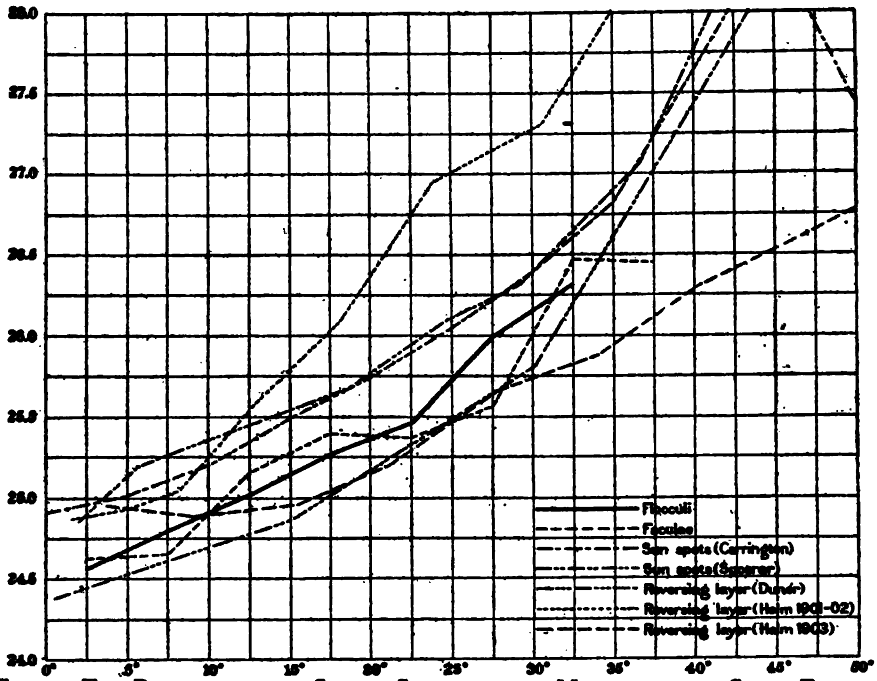

FIG. 5. THE ROTATION OF THE SUN AS SHOWN BY THE MOTIONS OF THE SPOTS, FACULÆ, FLOCCULI, AND REVERSING LAYER.

As the result of a long series of Sun-spot observations, Spoerer derived the following empirical formula, as best representing the diurnal motion of the spots in any latitude:

$$\xi = 8.548° + 5.798° \cos \phi$$

Computing the values of ξ corresponding to $\phi = 2.5°, 7.5°, 12.5°$, etc., and comparing the results with those we have obtained for the calcium flocculi, we have:

TABLE 6.

ϕ	Spoerer, spots ξ	Flocculi. ξ	Flocculi minus spots.
0° to 5°	14.34°	14.66°	0.32°
5 10	14.30	14.52	0.22
10 15	14.21	14.37	0.16
15 20	14.08	14.22	0.14
20 25	13.90	14.12	0.22
25 30	13.69	13.90	0.21
30 35	13.44	13.76	0.32

According to Spoerer's results, it would thus appear that the flocculi move more rapidly across the disk than the spots. The gain in 24 hours, taking the mean without regard to latitude, is about 0.2°.

However, this conclusion is not borne out by Mr. and Mrs. Maunder's extensive investigation of the Greenwich Sun-spot measures for the two complete cycles 1879-1901.[10] The results of this investigation, for the zones covered by our observations, are given in the following table:

TABLE 7.

ϕ	Greenwich spots. ξ	Flocculi. ξ	Flocculi minus spots.
2.5°	14.61°	14.66°	0.05°
7.5	14.50	14.52	0.02
12.5	14.44	14.37	−0.07
17.5	14.38	14.22	−0.16
22.5	14.14	14.12	−0.02
27.5	13.78	13.90	0.12
32.5	14.07	13.76	−0.31

Stratonoff's study of the solar rotation is based upon the measurement of the heliographic positions of faculæ photographed at Pulkowa, during the years 1891-94.[11] Wilsing had previously investigated this subject, with the aid of photographs made at Potsdam in 1884, and found for the faculæ a velocity of 14.27° in 24 hours, constant for all latitudes. This unexpected result caused Bélopolsky to attack the problem. Although he measured only a small number of photographs, he was able to detect the fact that the

[10] "The Solar Rotation Period from Greenwich Sun-spot Measures from 1879-1901." *Monthly Notices,* June, 1905.

[11] Stratonoff: "Sur le Mouvement des Facules Solaires." *Mémoires de l'Académie Impériale des Sciences de St.-Pétersbourg,* VIII Série, 1896.

faculæ in high latitudes rotate in a longer period than the spots at the equator. Stratonoff, with a much larger amount of material at his disposal, undertook to determine the law of rotation of the faculæ as a function of the latitude. 2,245 measures were made of 1,062 faculæ on 234 plates. As it was never possible to follow a facula more than four days from the limb, the measures were necessarily made on the least favorable part of the solar surface. In spite of this fact the following very satisfactory results were obtained. Our corresponding values for the flocculi are given for comparison.

TABLE 8.

ϕ	North. ξ	No. of observations.	South. ξ	No. of observations.	Faculæ, means. ξ	Flocculi, means.	Faculæ minus flocculi.
0° to 5°	14.62°	9	....	....	14.62° ±0.127°	14.66° ±0.026°	−0.04°
5 10	14.61	39	14.63°	9	14.61 ±0.061	14.52 ±0.020	0.09
10 15	14.34	125	14.26	67	14.31 ±0.044	14.37 ±0.016	−0.06
15 20	14.14	110	14.21	124	14.18 ±0.036	14.22 ±0.019	−0.04
20 25	14.21	124	14.17	137	14.19 ±0.036	14.12 ±0.026	0.07
25 30	13.97	109	14.20	101	14.08 ±0.040	13.90 ±0.049	0.18
30 35	13.50	15	13.65	34	13.60 ±0.059	13.76 ±0.067	−0.16
35 40	....	....	13.61	24	13.61 ±0.086	....	....

It appears from the table that the observed differences in the daily motion of the faculæ and flocculi are of the same order as the probable errors, except in the higher latitudes, where the observations are few and the results uncertain.

Let us now consider whether the daily motion of the flocculi decreases at a uniform rate in passing from the equator toward high latitudes. For comparison, we also include Stratonoff's results for the faculæ. The quantities in the columns $\Delta\xi$ are obtained by subtracting the value of ξ for each zone from the value of ξ in the zones +5° −5°, which we take as the standard velocity.

TABLE 9.

ϕ	Faculæ.			Flocculi.		
	North. $\Delta\xi$	South. $\Delta\xi$	Mean. $\Delta\xi$	North. $\Delta\xi$	South. $\Delta\xi$	Mean. $\Delta\xi$
5° to 10°	0.01°	0.01°	0.01°	0.16°	0.11°	0.14°
10 15	0.28	0.36	0.31	0.32	0.27	0.29
15 20	0.48	0.41	0.44	0.52	0.36	0.41
20 25	0.41	0.35	0.43	0.53	0.55	0.54
25 30	0.65	0.42	0.54	0.92	0.63	0.76
30 35	1.12	0.97	1.02	1.02	0.73	0.89
35 40	....	1.01	1.01	....	....	....

It thus appears that the acceleration is very nearly uniform. Indeed, the entire series may be fairly well represented by a straight line, since the larger deviations can be given little weight, as they correspond to zones in which few observations are available.

An interesting investigation of the rotation period of the Sun, based upon the motion of large groups of faculæ, is that of Wolfer.[12] He found that during the period in question (1887-90) there were two persistent groups of faculæ, of great size, on the Sun, about 180° apart in longitude. Each group showed a gradual increase in longitude, which continued during the entire period. As the longitudes were based upon Spoerer's mean daily value of 14.2665°, derived from observations of the spots, it follows that the faculæ were moving more rapidly than the spots, if we may assume that Spoerer's mean daily value can be depended upon. Maunder's results, however, as already remarked, throw doubt on this point and the question can not at present be regarded as settled.

Let us now compare our results for the flocculi with those of Dunér for the reversing layer. Dunér's determination of the solar rotation was made by measuring the double displacement of two iron lines, λ 6301.72 and λ 6302.72, referred to neighboring telluric lines. The radial velocities found for different latitudes therefore represent the motion of the iron vapor in the reversing layer. Dunér's observations correspond to the latitudes 0.4°, 15.0°, 30.1°, 45.0°, 60.0°, and 75.0°. In order to obtain velocities corresponding to the mean latitudes of our zones, Dunér's formula II, adapted from Spoerer's formula for the spots, has been used.[13] The values of ξ have thus been obtained by substituting 2.5°, 7.5°, 12.5°, 17.5°, 22.5°, 27.5°, and 32.5° for ϕ in the formula:

$$\xi = 8.564° + 6.153° \cos \phi$$

TABLE 10.

ϕ	Reversing layer. ξ	Flocculi, means. ξ	Reversing layer minus flocculi.
0° to 5°	14.71°	14.66°	0.05°
5 10	14.66	14.52	0.14
10 15	14.57	14.37	0.20
15 20	14.43	14.22	0.21
20 25	14.25	14.12	0.13
25 30	14.02	13.90	0.12
30 35	13.75	13.76	−0.01

So far as can be judged from this comparison, in all latitudes excepting the highest, which is of low weight in the flocculi determinations, the reversing layer gives higher velocities than the calcium flocculi, the average difference in the value of ξ amounting to about 0.014°. Since the corresponding difference in the case of Spoerer's spots is about 0.2°, and of opposite sign, the Sun would appear to have a gradually increasing rotational velocity in the order spots, faculæ and flocculi, reversing layer, were it not for Maunder's results.

[12] A. Wolfer: "Zur Bestimmung der Rotationszeit der Sonne," *V. J. S. d. zürch. naturforsch. Ges.*, Bd. 41.
[13] *Astronomische Nachrichten*, No. 3994.

It is an interesting question whether the apparently greater velocity of the iron vapor in the reversing layer, as compared with the faculæ and flocculi, is genuine. The average results of Halm's observations, covering the period 1901-06, would point to a contrary conclusion. They are given in the following table, extracted from his more complete table in *Astronomische Nachrichten*, No. 4146.

TABLE II.

ϕ	Linear velocity.	No. of observations.	Daily motion. ξ	ϕ	Linear velocity.	No. of observations.	Daily motion. ξ
2.3°	2.042 km.	103	14.55°	21.4°	1.856 km.	43	14.19°
6.6	2.032	69	14.56	24.5	1.788	55	13.98
9.4	2.002	65	14.44	27.6	1.755	53	14.09
12.4	1.972	44	14.37	30.7	1.657	41	13.72
15.6	1.952	55	14.42	33.3	1.596	45	13.59
18.4	1.907	64	14.31	36.4	1.561	51	13.81

These results differ decidedly from Dunér's, especially in the lower latitudes (see fig. 5). It may be added, however, that an unpublished series of measures by Adams, covering the period June 1906 to February 1907, gives results in very close agreement with Dunér's, up to a latitude of 45°. Beyond this point the reductions are not yet complete. The very high precision of Adams's measures lends great weight to his confirmation of Dunér's results.[14]

We do not attempt to discuss here the unsettled question of a possible variation in the rotational velocity of the Sun, indicated by Halm's measures for 1901-02 and 1903. The apparently high accuracy of Halm's results appears favorable to his conclusions, but it must remain for the future to prove whether such variations actually occur.

It can not be said from the comparisons given above that a systematic difference of velocity of various classes of solar phenomena has been demonstrated. So far as the flocculi are concerned, no very general discussion of their motions could be based on the restricted materials now available. We are both engaged in work with powerful instruments, which furnish larger solar photographs, much richer in detail and better suited for measurement than the Kenwood plates. We accordingly expect to return to this discussion, with the advantage afforded by a longer series of better observations. A more general consideration of the problem of the solar rotation, and a more accurate estimate of the weight to be attached to measurements of the velocity of various classes of phenomena, should then be practicable.

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[14] Since this paper was put in type the following articles on the solar rotation have appeared in *Contributions from the Mount Wilson Solar Observatory*, Nos. 20, 24, and 25.
Spectroscopic Observations of the Rotation of the Sun. By Walter S. Adams. *Astrophysical Journal*, XXVI, November, 1907.
Preliminary Note on the Rotation of the Sun as Determined from the Displacements of the Hydrogen Lines. By Walter S. Adams. *Astrophysical Journal*, XXVII, April, 1908.
Preliminary Note on the Rotation of the Sun as Determined from the Motions of the Hydrogen Flocculi. By George E. Hale. *Astrophysical Journal*, XXVII, April, 1908.

FUTURE STUDIES OF THE SOLAR ROTATION.

A general attack on the problem of the solar rotation calls for the co-operation of several observatories. It should include:

(1) Further investigations of the motions of individual spots, closely connected with: (*a*) simultaneous determinations of their level, made with the spectroheliograph; (*b*) their appearance at and near the limb (visibility of umbra, etc.), also bearing upon the question of level; (*c*) their spectra, including general absorption, and relative intensity of lines,[13] bearing on their temperature and level; (*d*) measures of the solar activity, particularly in the zone occupied by the spots in question.

(2) A continuation of Maunder's work on spot motions.

(3) A continuation of Stratonoff's work on the motions of the faculæ, using such means of increasing contrast as will permit the inclusion of faculæ near the center of the Sun.

(4) Investigations with the spectroheliograph on the motions of (*a*) the bright regions photographed with the H_1 or K_1 lines; (*b*) the H_2 or K_2 calcium flocculi; (*c*) if possible, the H_3 or K_3 dark calcium flocculi; (*d*) the hydrogen flocculi; (*e*) the iron flocculi, and those of other gases.

(5) A continuation and extension of the spectroscopic work of Dunér and Halm, on the motion in the line of sight of the reversing layer at opposite limbs of the Sun. This investigation, which would necessarily require the co-operation of several observatories, should provide for the employment of certain lines in common by all observers. It should also involve the use, by each observer, of certain additional lines, chosen so as to include: (*a*) a considerable number of lines in the spectrum of at least one substance; (*b*) lines representing elements of high, medium, and low level; (*c*) lines enhanced in the spark, and those strengthened at low temperatures.

(6) An investigation of the motion in the line of sight of the lower chromosphere (or reversing layer), through spectroscopic observations of the relative displacements of *bright* lines at opposite limbs of the Sun.

(7) A determination of the motion in the line of sight of quiescent prominences, in various latitudes and at various heights above the limb.

SUMMARY.

This investigation of the motion of the calcium flocculi has led to the following conclusions:

1. The rotation periods for different latitudes show the existence of an equatorial acceleration, similar to that previously observed in the case of Sun-spots, faculæ, and the reversing layer.
2. In approximate terms, the acceleration varies uniformly with the latitude.
3. The average daily motion of the calcium flocculi is of the same order as that of the spots, faculæ, and reversing layer. The differences among the rotation periods obtained by various observers are so marked that no definite conclusions can yet be drawn as to the relative velocities of these different phenomena.

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[13] See Hale, Adams, and Gale. "Preliminary Paper on the Cause of the Characteristic Phenomena of Sun-Spot Spectra." *Astrophysical Journal*, October, 1906.